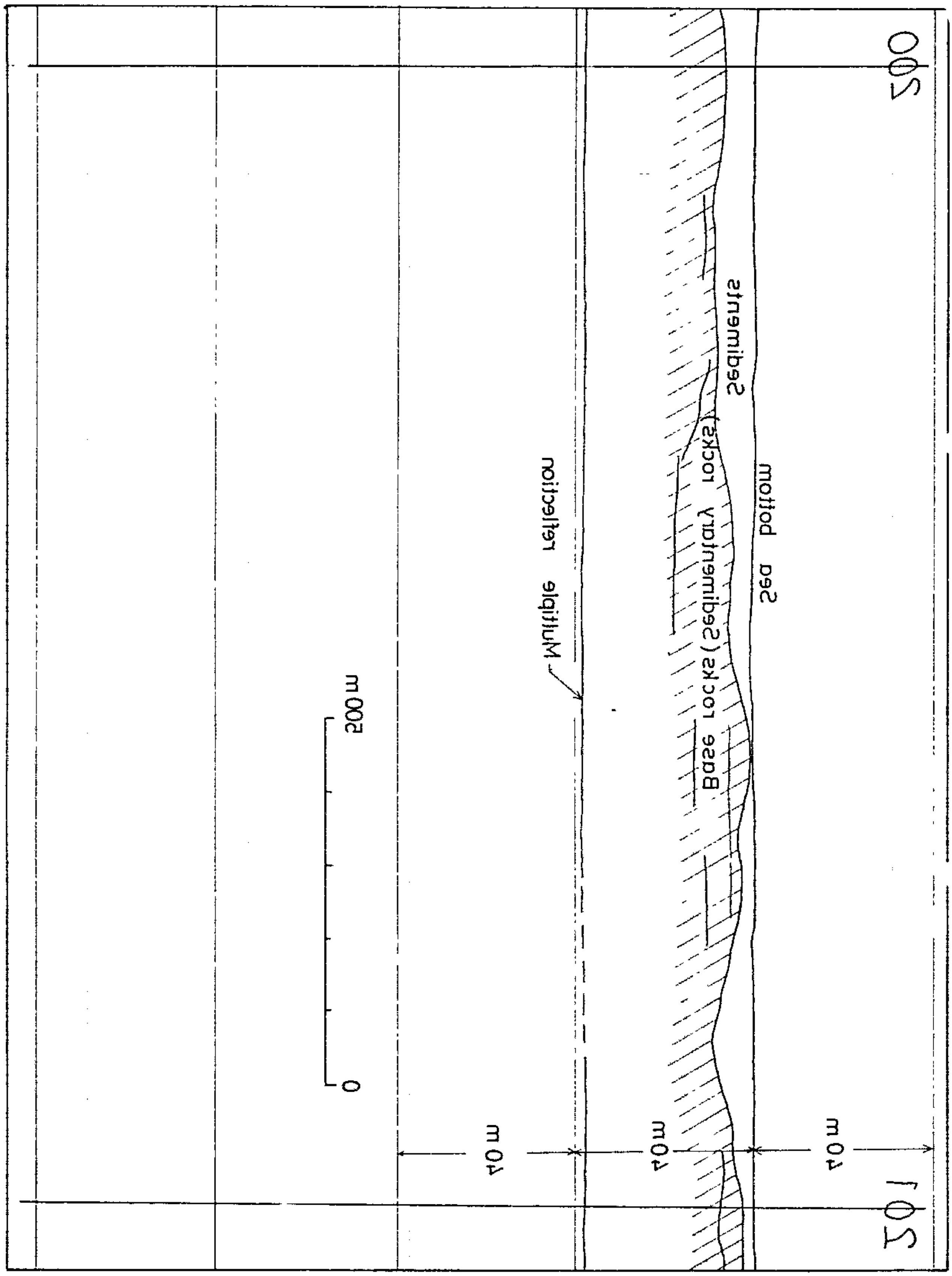


200
201
40 m
40 m
40 m
0
500 m
Multiple reflection
Sea bottom
Sediments
Base rocks (Sedimentary rocks)

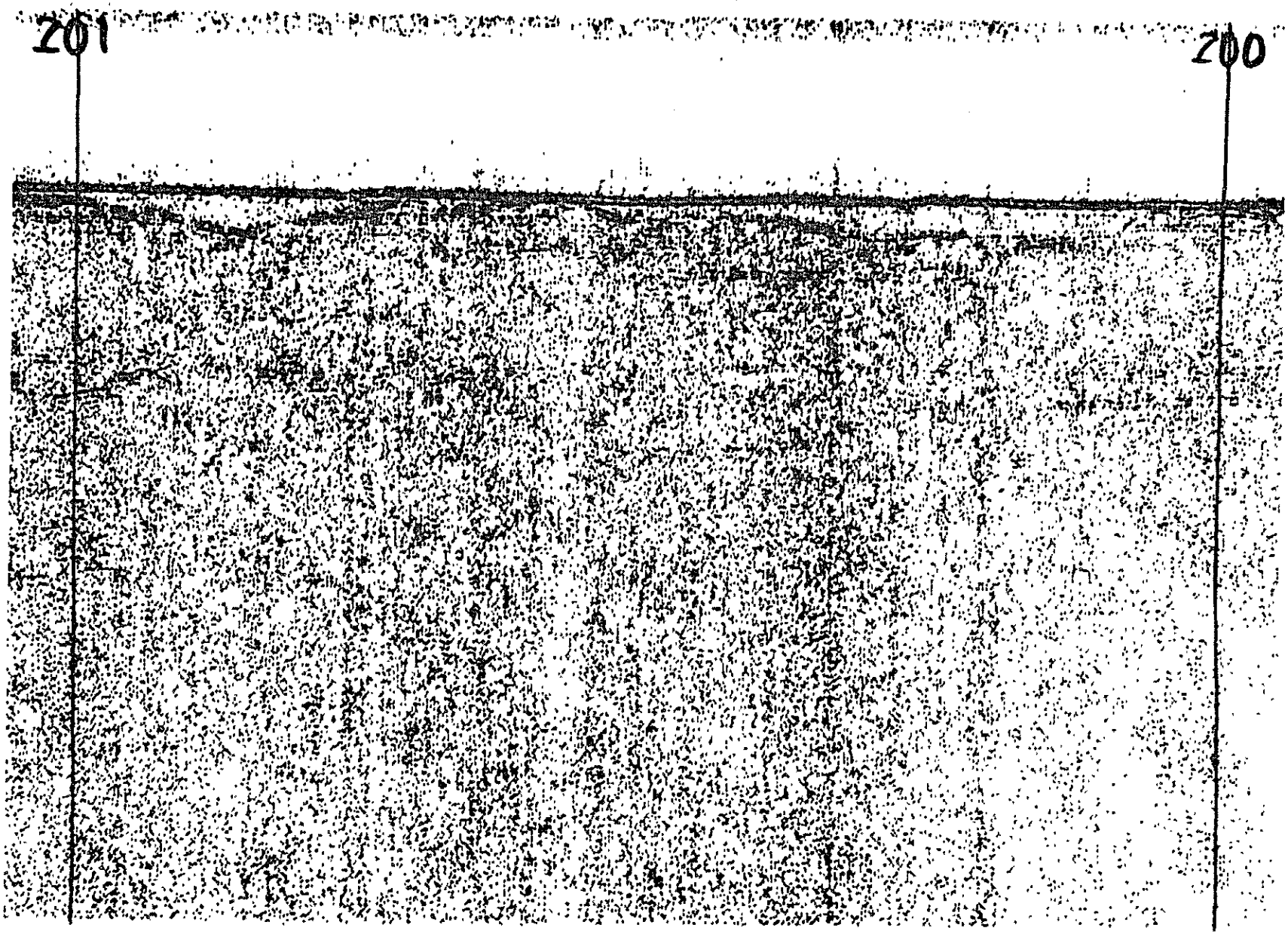
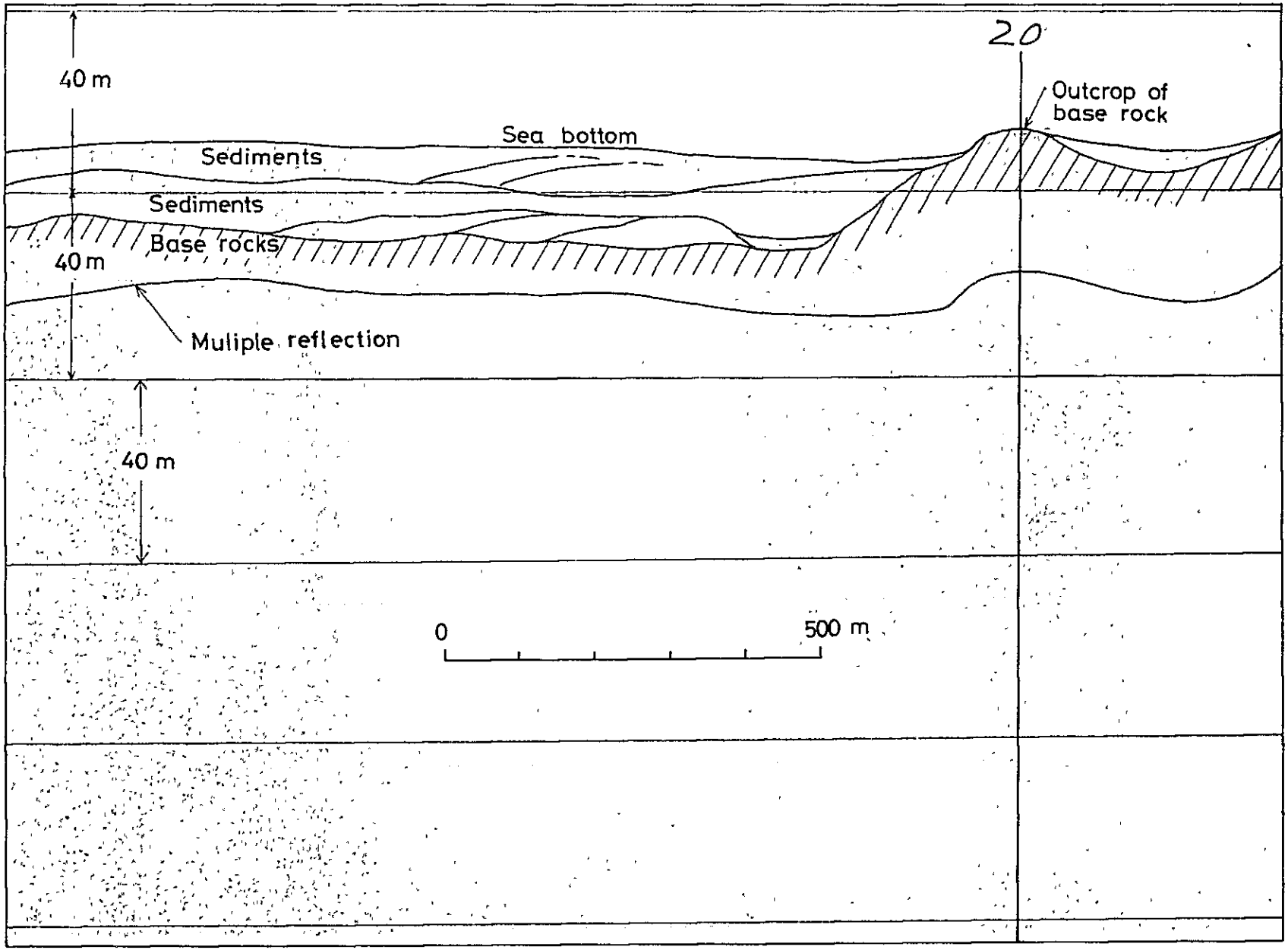
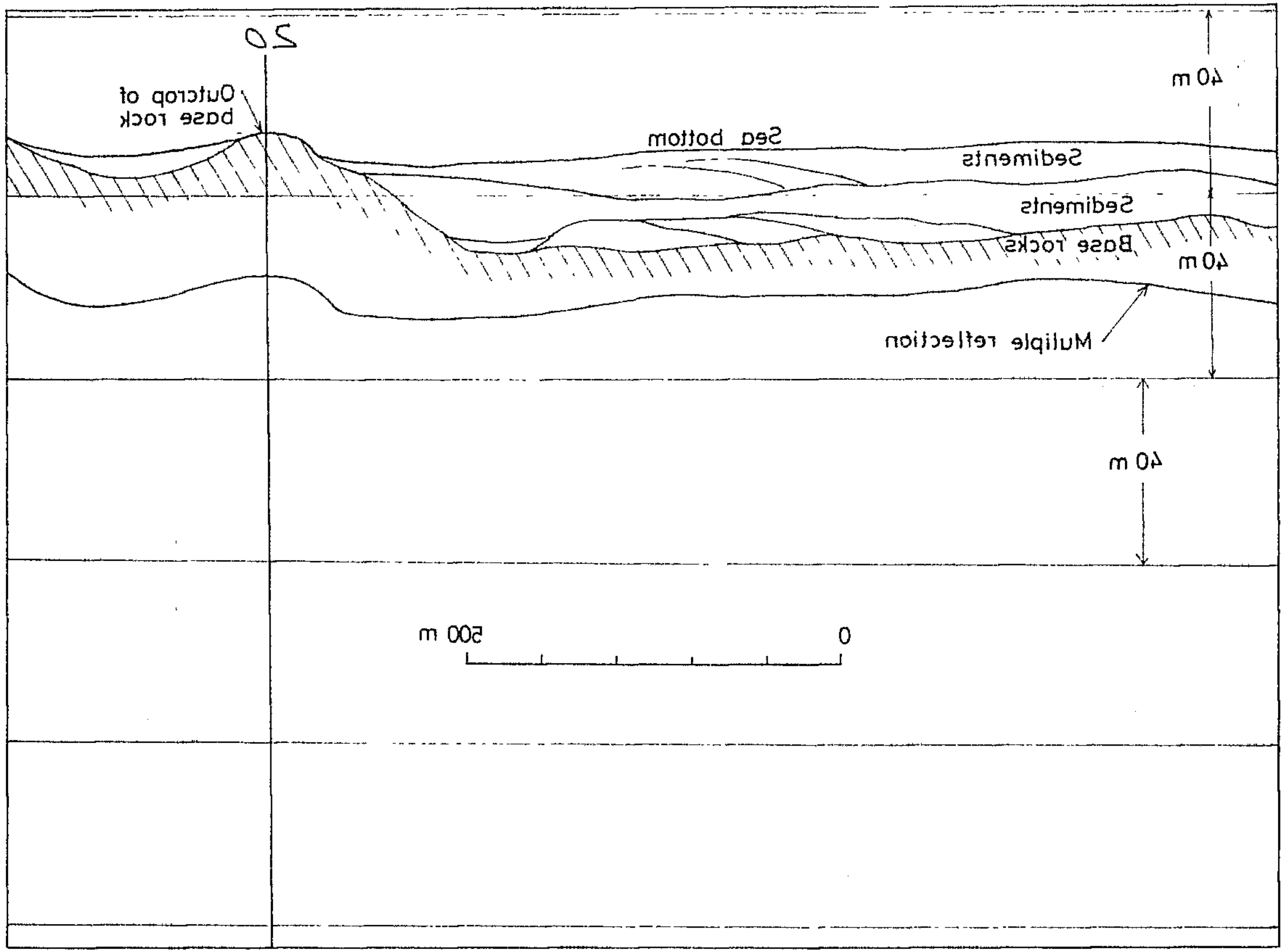


Fig.3.5.15(f) RECORD ON SPARKER


20
40 m
Outcrop of
base rock
Sea bottom
Sediments
Sediments
Base rocks
40 m
Muliple reflection
40 m
0
500 m


20
Outcrop of
base rock
Sea bottom
Sediments
Sediments
Base rocks
Mulijple reflection
40 m
40 m
40 m
0
500 m

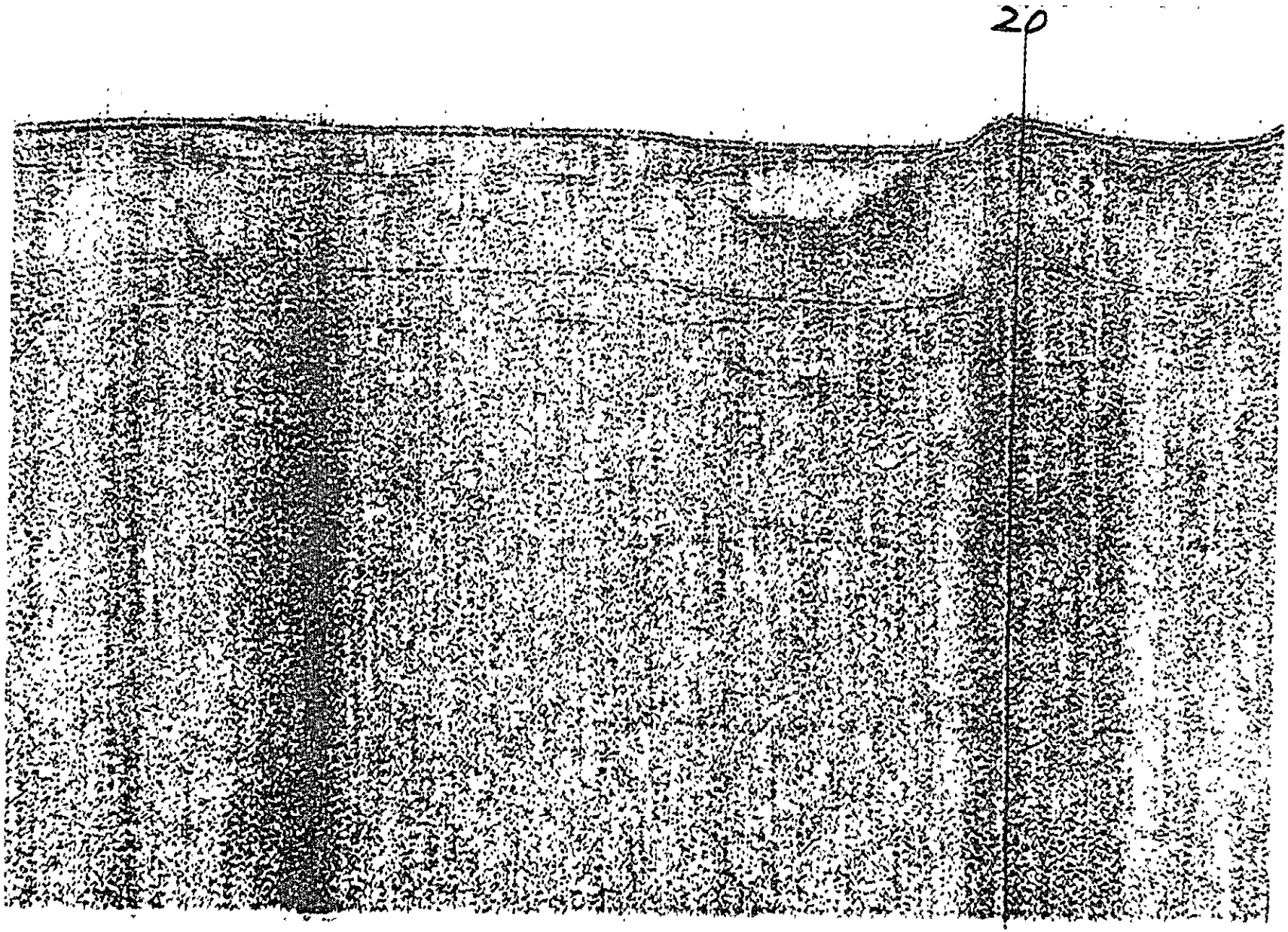


Fig.3.5.15(g) RECORD ON SPARKER

3.5.6　水温および予測海底水温変動

(1)　水温

水温測定はＥＴ－５型水温計を使用して，採泥を行った箇所について実施した。主測線上の各観測点の海底水温はTable3 5.1(a)(b)に示すとおりで，その垂直分布はFig3.5.16(a)～(d)に示すとおりである。沿岸部の水温は海底および海面で殆んど差は無いが，沖合部では水深３０m付近で水温躍動が認められた。

(2)　予測海底水温変動

日本海洋データセンターの統計資料によれば，調査ルート沿いの海底水温変動は季節風の影響を受けて方向の変る流れに支配されている。一般に浅海部においては海水表面の水温変動がそのまゝ海底水温に影響するので，深海部に比し変動幅が大きい。

Fig3.517は統計による予測海底水温変動と，今回の観測値を示し，観測結果は統計資料と合致している。調査ルートの海底水温変動として，２８.０°±４℃を見込めば充分である。

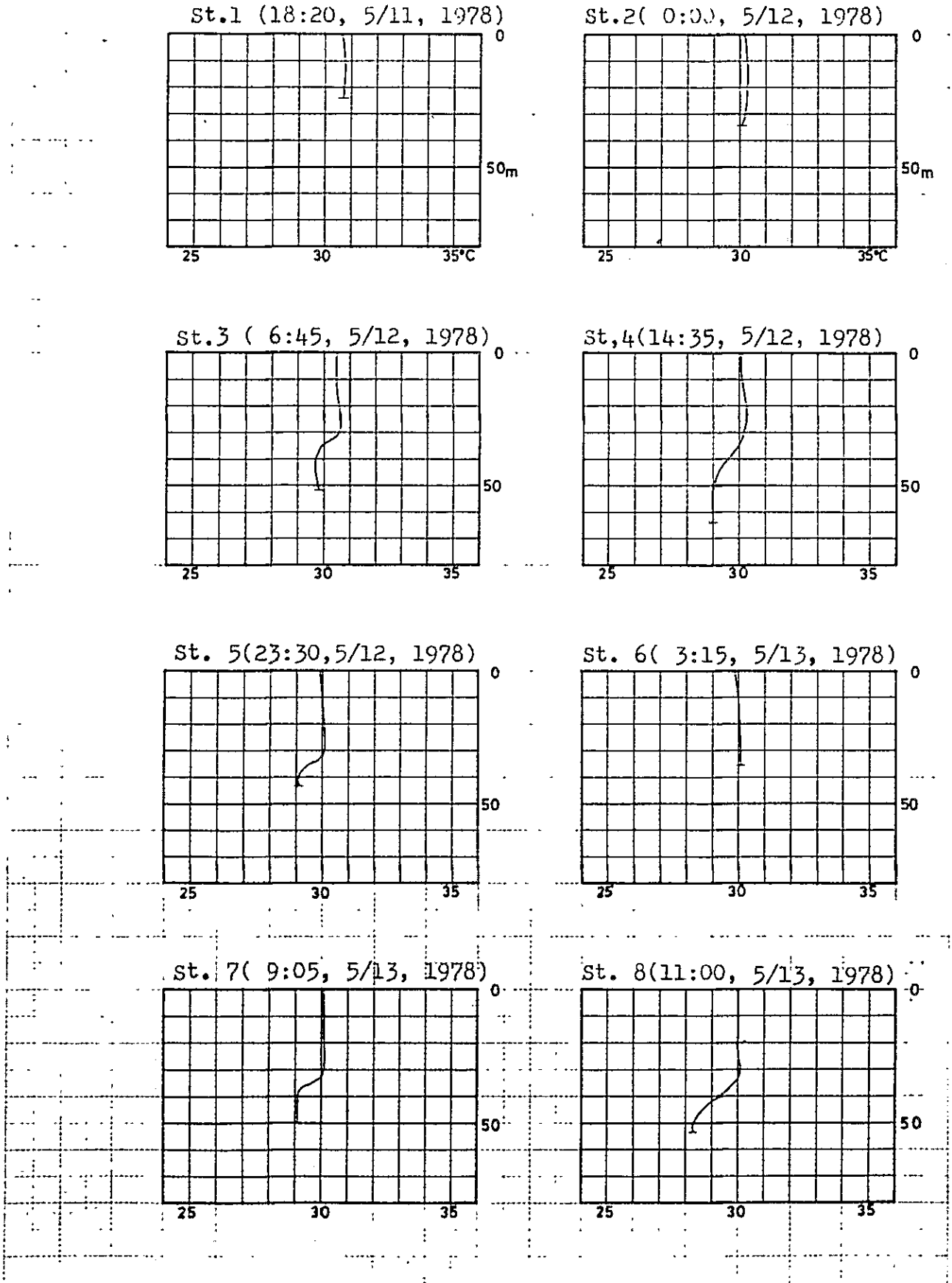


Fig.3.5.16 (a) VERTICAL DISTRIBUTION OF WATER TEMPERATURE (IN °C)

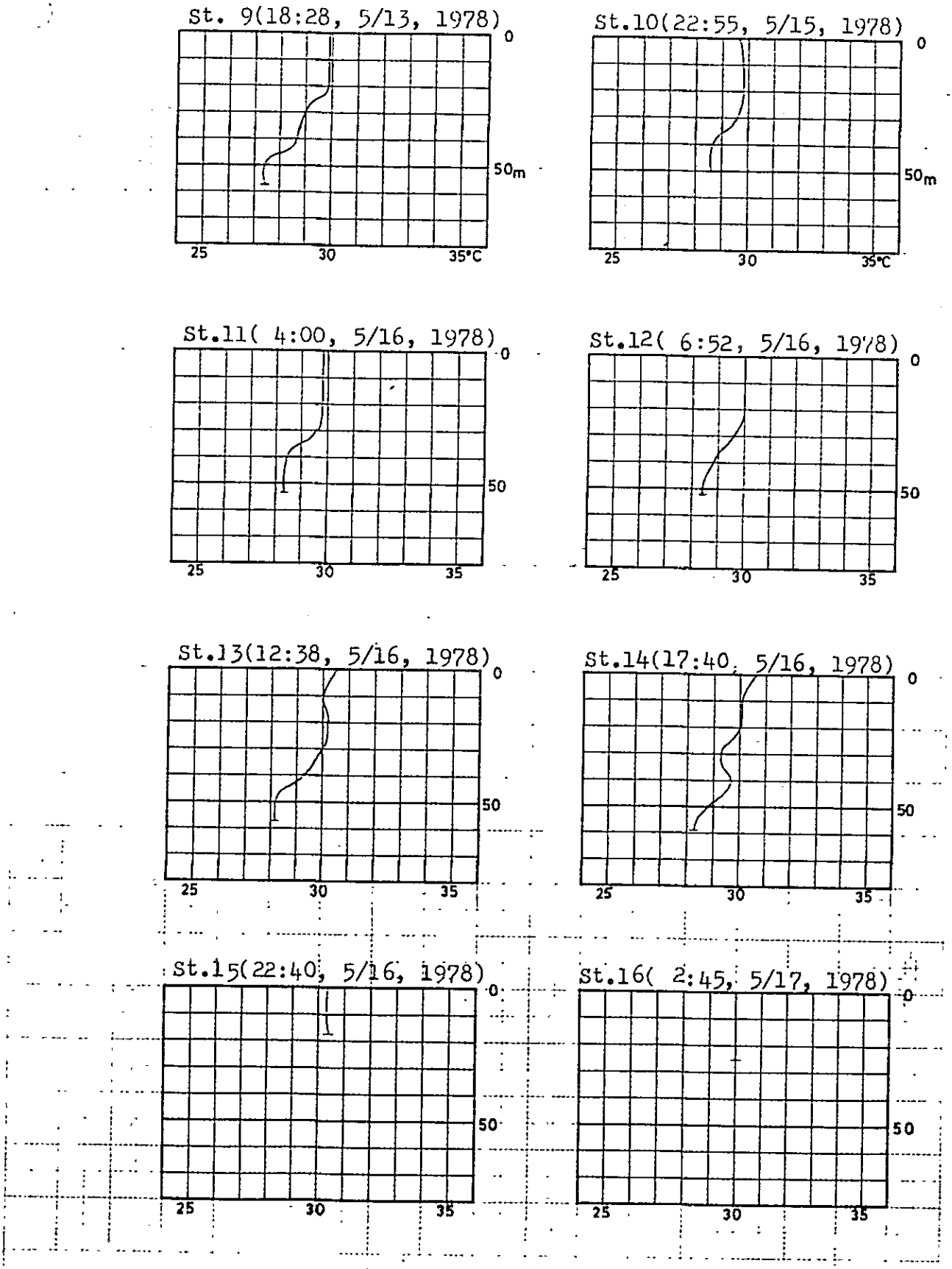


Fig.3.5.16 (b) VERTICAL DISTRIBUTION OF WATER TEMPERATURE (IN °C)

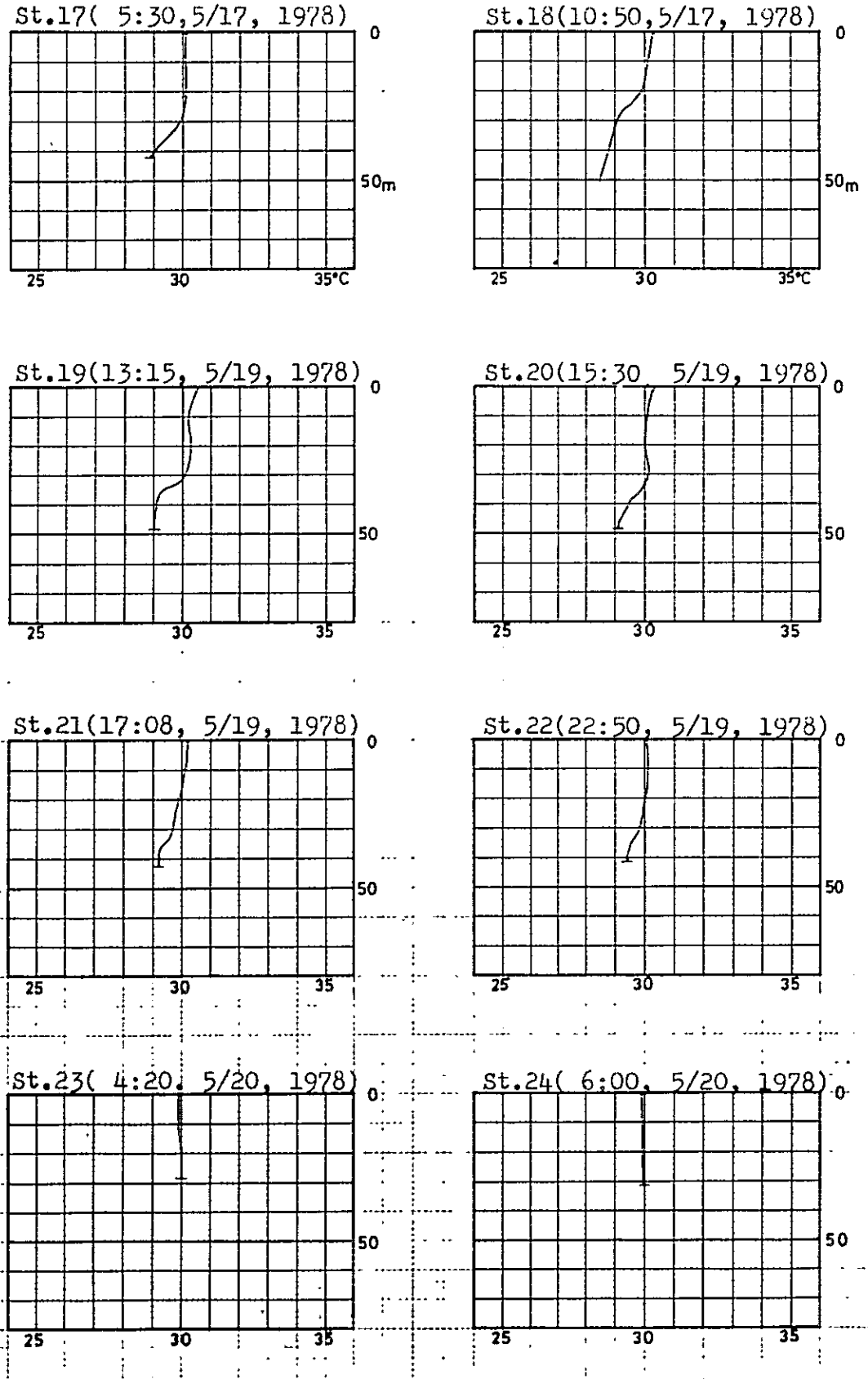


Fig.3.5.16 (c) VERTICAL DISTRIBUTION OF WATER TEMPERATURE (IN °C)

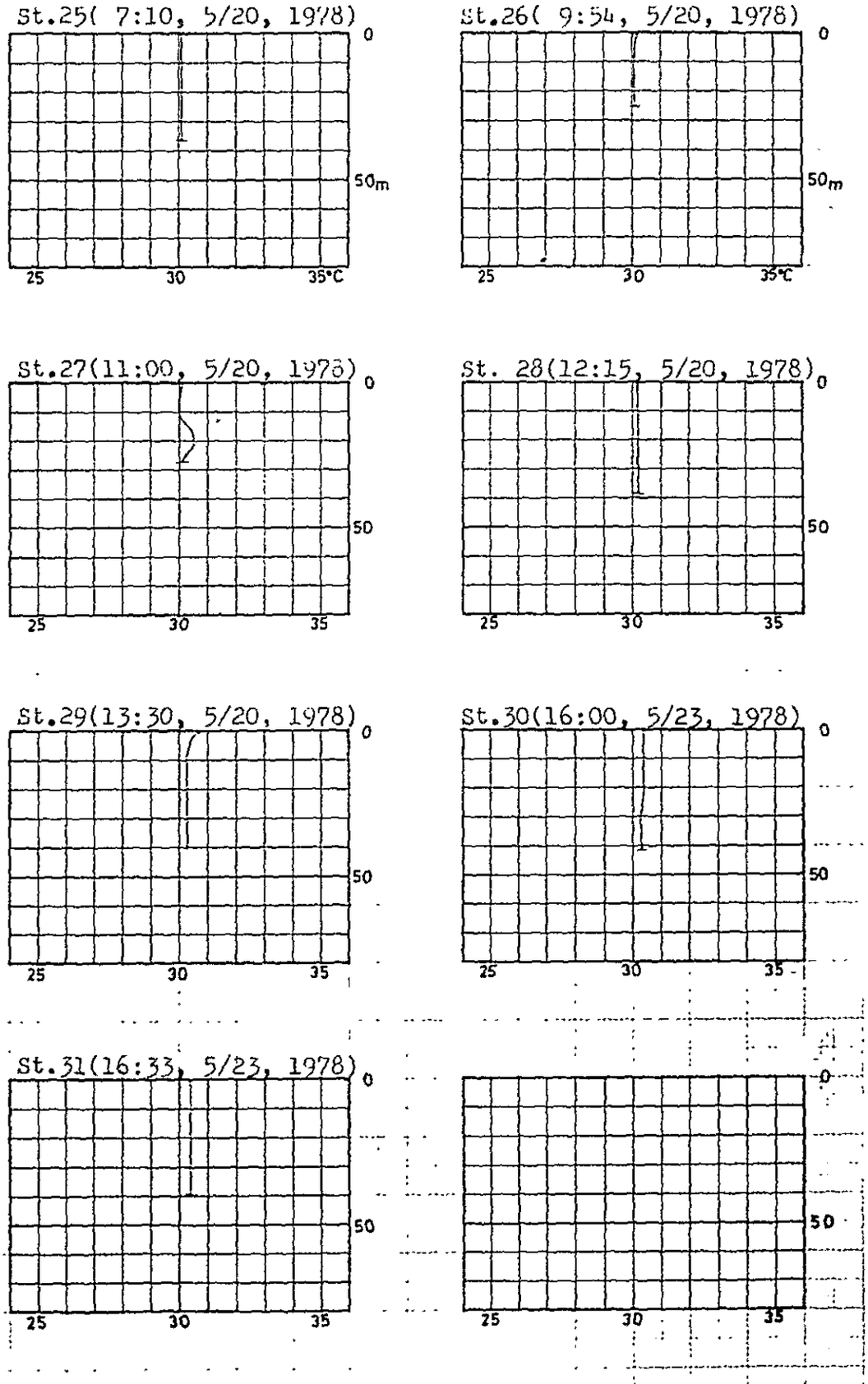
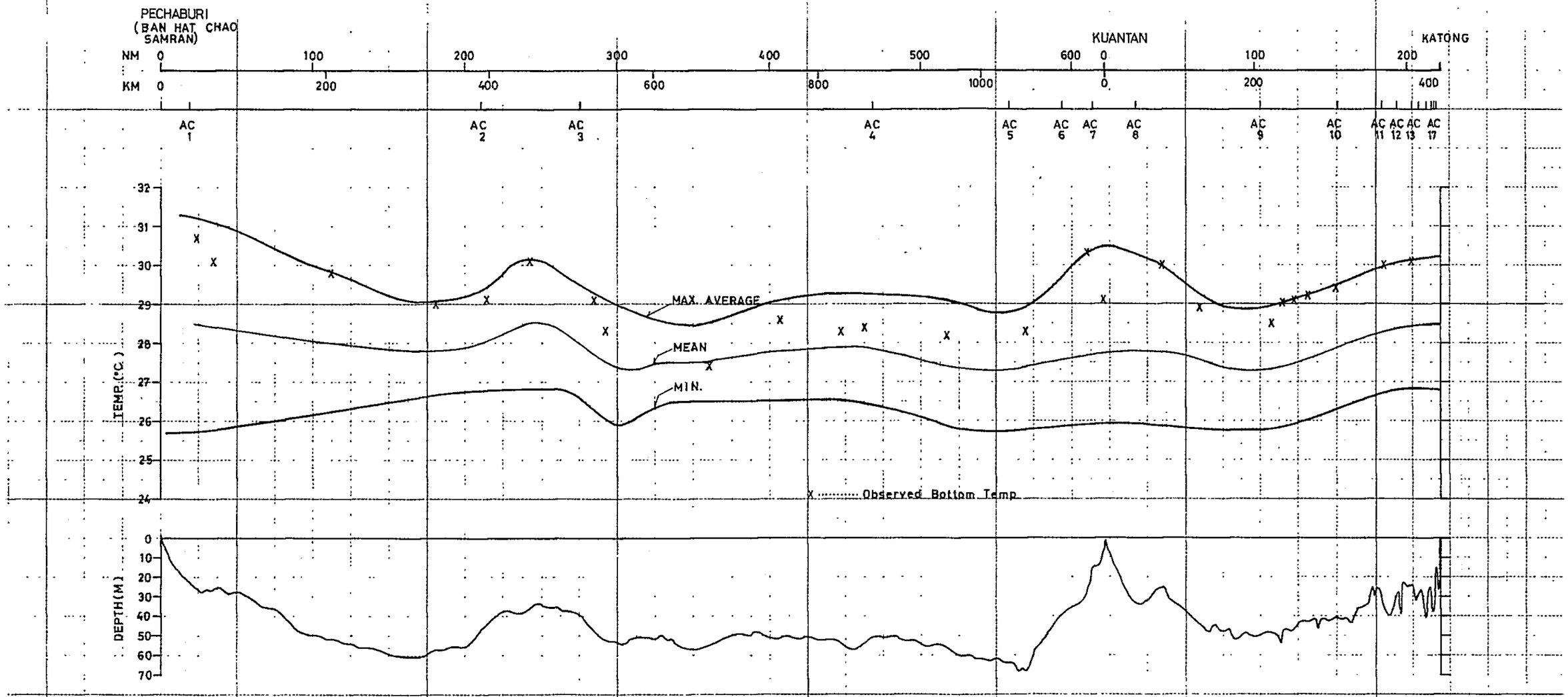


Fig.3.5.16 (d) VERTICAL DISTRIBUTION OF WATER TEMPERATURE (IN °C)

Fig. 3.5.17. BOTTOM TEMPERATURE AND ITS VARIATION.



3.5.7　海流および潮流

(1)　季節による海流

南シナ海付近の主要海流は主として吹送流で冬季々節風と夏季々節風と密接な関係をもっている。Fig 3.5.18(a)(b)は2つの季節にまとめたものである。

(a)　北東季節風季（11月～3月）

北東季節風の盛吹期は11月～3月の間である。この時期には充分に発達した海流が南シナ海を南方に航走する。この海流は北緯4°付近に至るまで西南西～南南西流が卓越しスマトラ－ボルネオ間を通過しジャワ海に入るとき南東の流れに変る。

一方マレイシア東岸に到達した流れは，一部は北上しタイ湾に入り，やゝ弱まってその主方向は時計廻りの環境となっている。又一部はマレイシア東岸沿いに南下し主流はジャワ海にぬけ，支流はシンガポール海峡を通る西流となる。平均海流はペチャブリ～クアンタン間は0.4～1.0ノットであり，クアンタン以南は，やゝ流速を増す傾向にありその平均流速は0.4～1.5ノットとなっている。

(b)　南西季節風季（6月～9月）

この季節に於ける海流はおゝむね北東季節風季中のものと相反する傾向にあり，相当に顕著であるが冬季の北東季節風季とくらべるとやゝ弱い。

ジャワ海から南シナ海に入りこんだ流れの一部はシンガポール海峡を西に，マレイシア東岸沿いにそれぞれ向かっている。タイ湾に入りこんだ流れはやゝ弱まり北東季節風季と同様時計廻りの傾向を示すようである。ペチャブリ沖では0.2～0.6ノットクアンタン沖では0.5ノット～1.5ノットの流速となっている。

その外，4月，5月および10月は季節風交代期である。

流速は弱まるが，4月および10月は北東季節風季の，5月は南西季節風季の傾向をそれぞれ示している。

(2)　潮流

本海域における潮汐は日潮不等が大きく1日1回潮となることが多いため，潮流も一般には1日1回潮流となることが多い。（潮汐と潮流との間には必ずしもこのような関係はもたない。）また季節風及び海流の影響を受けることが多い。タイ湾西部沿岸は一般に上げ潮流は北方に下げ潮流は南方に流れ，その流速は1ノットにみたない。

マレイシア東岸では上げ潮流は南方に，下げ潮流は北方に流れ高低潮后2－3時間后に転流する。1977年12月調査したクアンタンークチン間海底ケーブル建設計画の報告書によれば，クチン沿岸部では北北東の流れが卓越し，反対方向の流れ（南々西）は弱い。観測した流れの最強のものは190°方向へ0.74ノットであった。

シンガポール海峡部の潮流は日周潮流が大きく1日1回の潮流となることが多く流速は大陰

の赤緯の大きい時最大となる（Appendix　１２参照）。一般に高潮前１時間より約１２時間は東方に，その他の１２時間は西方に流れその流速は２～３ノットに達する。また大陰の赤緯が小さい時には上げ潮流は西方に，下げ潮流は東方に流れその流速は弱い。

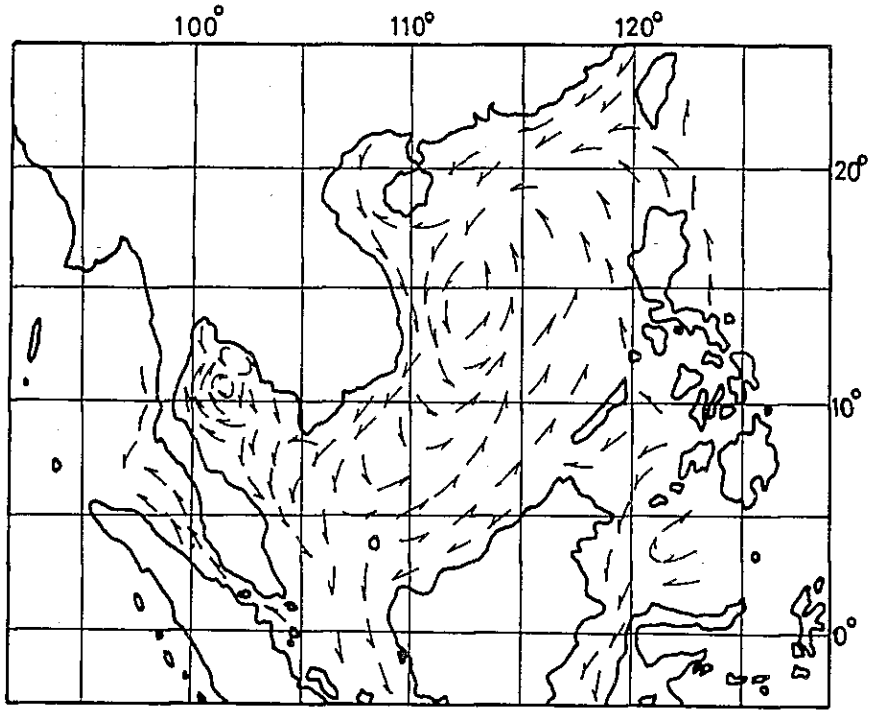


Fig 3 5 18(a) OCEAN CURRENT DURING THE NORTHEAST MONSOON SEASON

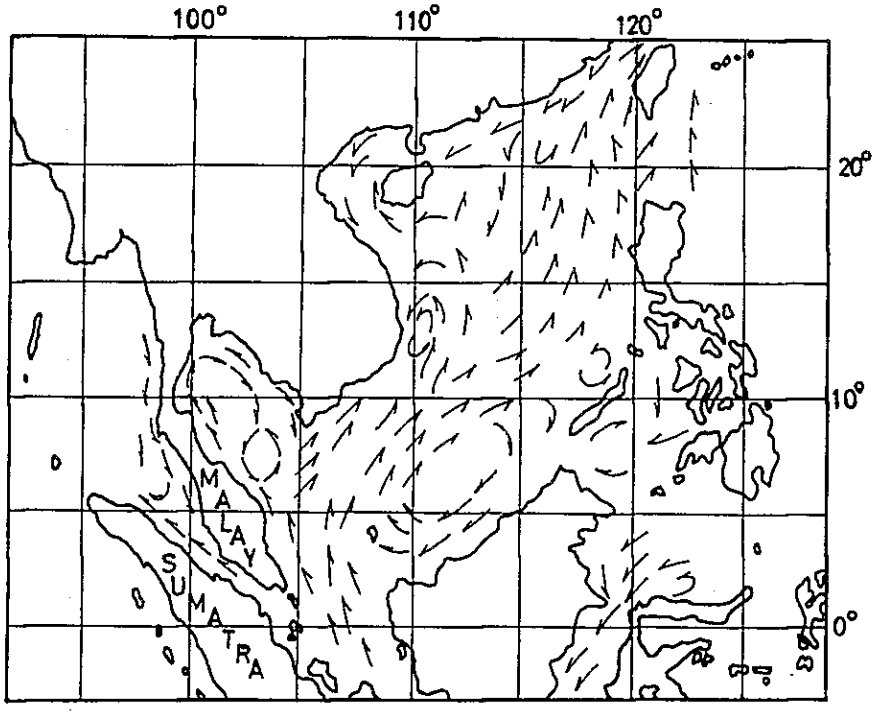


Fig. 3.5.18(b) OCEAN CURRENT DURING THE SOUTHWEST MONSOON SEASON

3.5.8　陸揚地

ペチャブリ，クアンタンおよびカトンの陸上部測量結果をそれぞれFig 3.5.19(a)(b)(c)に示す。各陸上部とも顕著な起伏変化は見られず平坦である。地表面は水深の基準面より，ペチャブリで3.5 m，クアンタンで5.5 mおよびカトンでは38 mそれぞれ高くなっている。陸揚点からの固定目標方向に対するケーブルルートの方向をFig 3.5.20(a)(b)(c) 示す。なお陸上部測量結果についてクアンタンは，1977年調査のクアンタン－クチン海底ケーブル資料を使用し，一部落付近の地形を補測したのみである。

またカトンについても測量は行なわず，シンガポール・テレコムスより提供された資料により作製したものである。

Fig. 3.5.19(a) CABLE LANDING SITE (PECHABURI; BAN HAT CHAO SAMRAN)

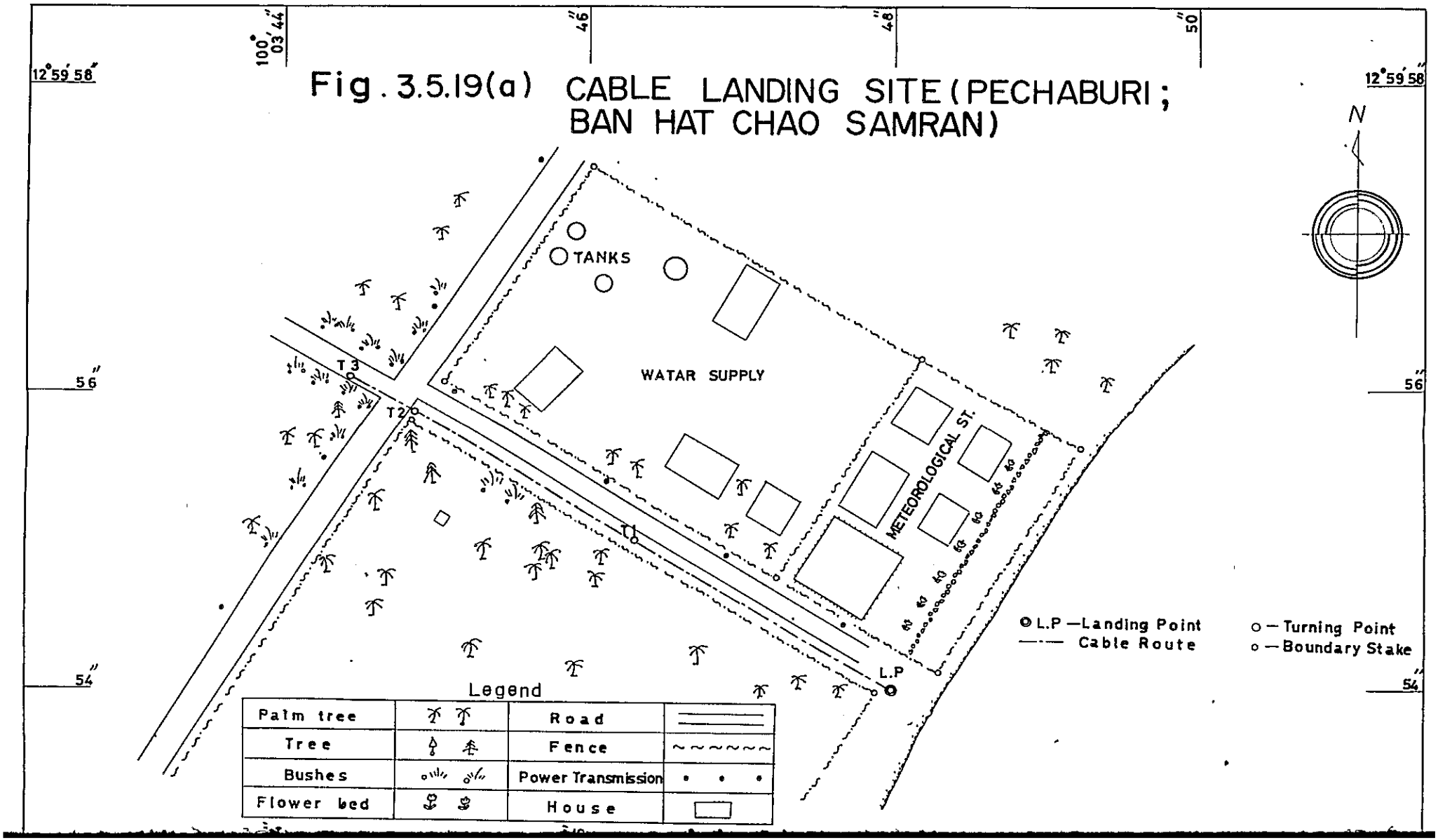
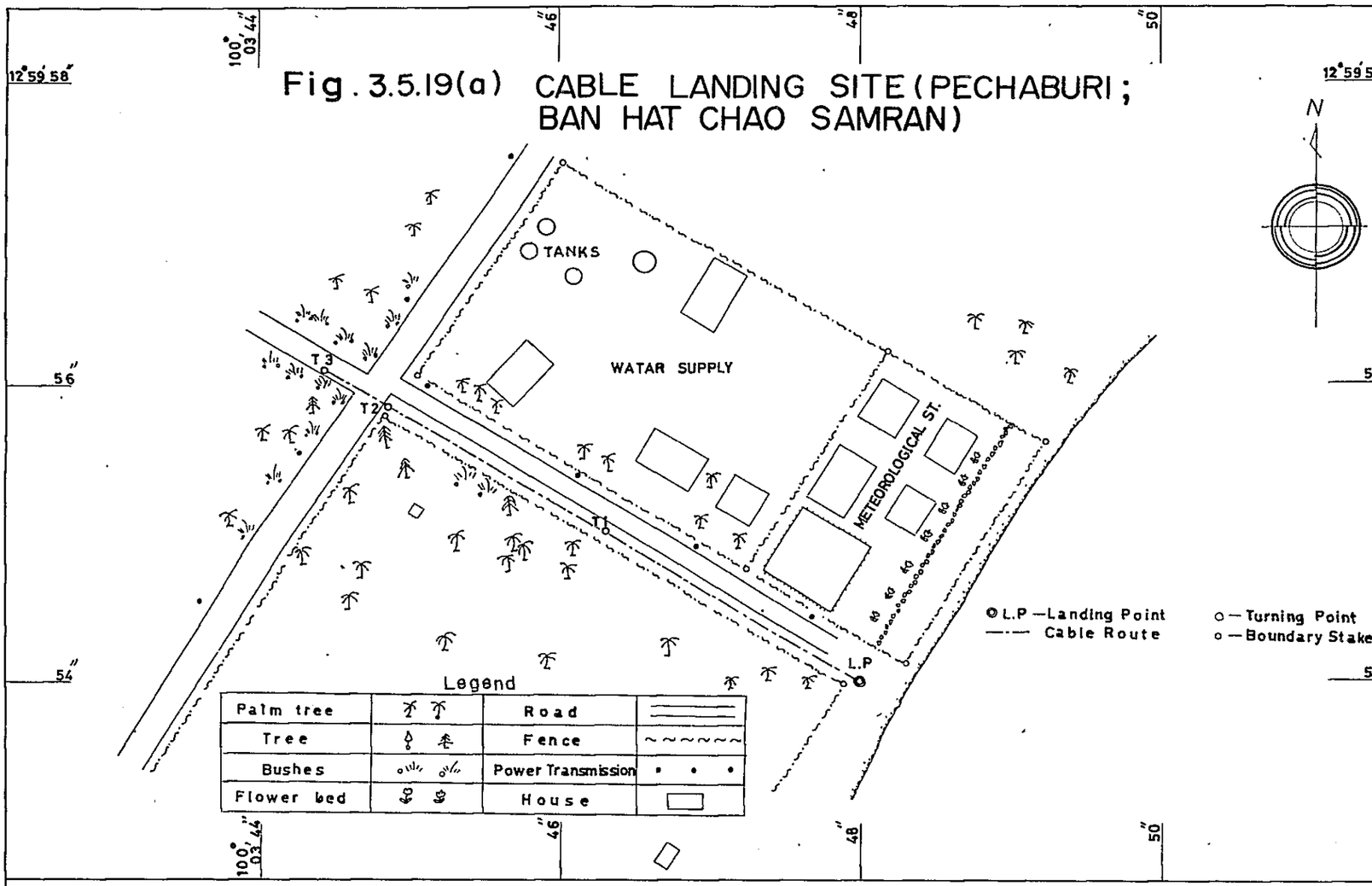


Fig. 3.5.19(a) CABLE LANDING SITE (PECHABURI; BAN HAT CHAO SAMRAN)



1 : 3.000

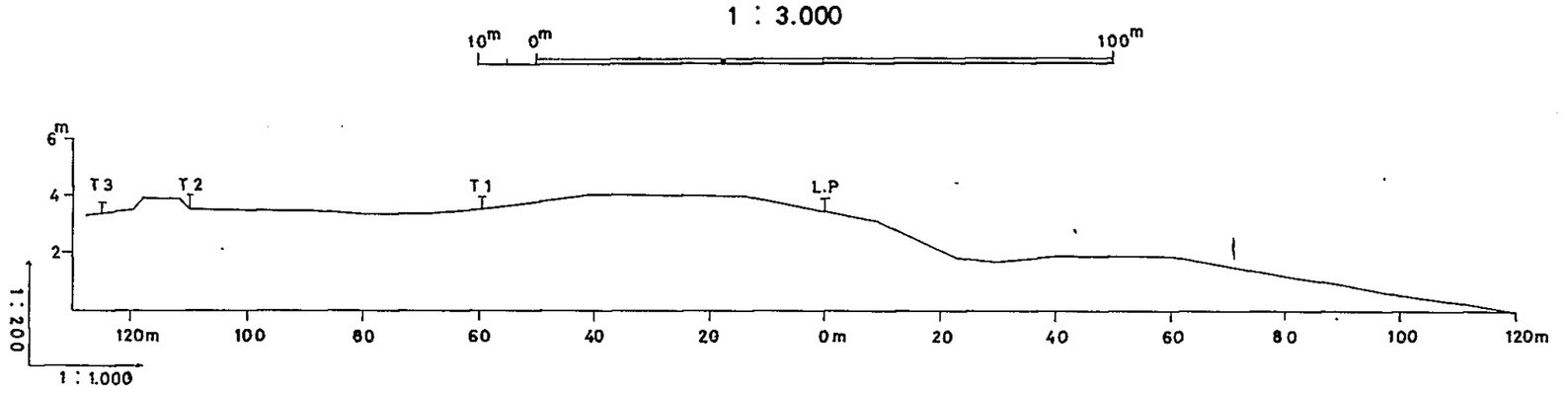


Fig.3 5 19 (b) CABLE LANDING SITE (KUANTAN)

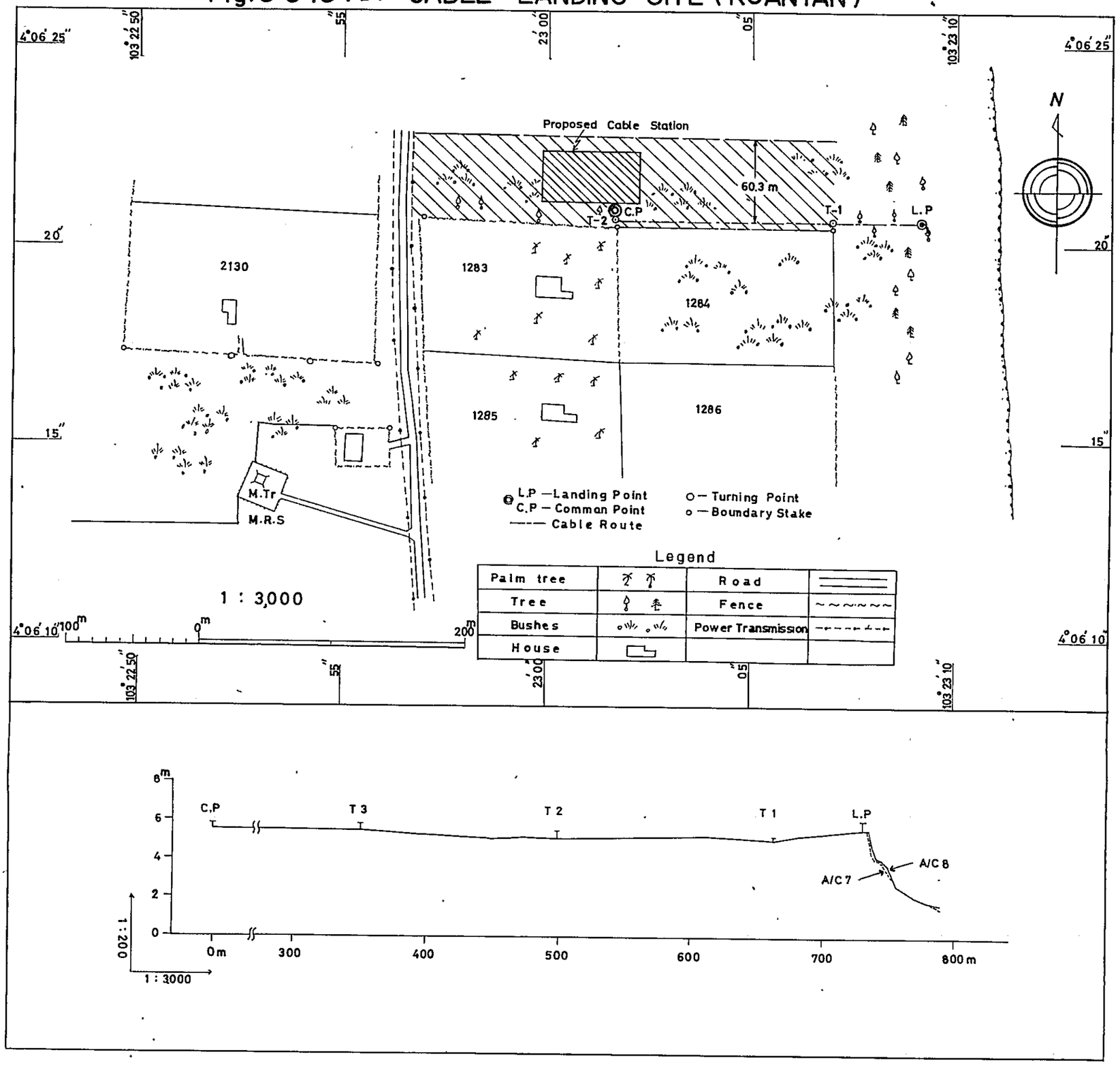


Fig. 3.5.19(C) CABLE LANDING SITE (KATONG)

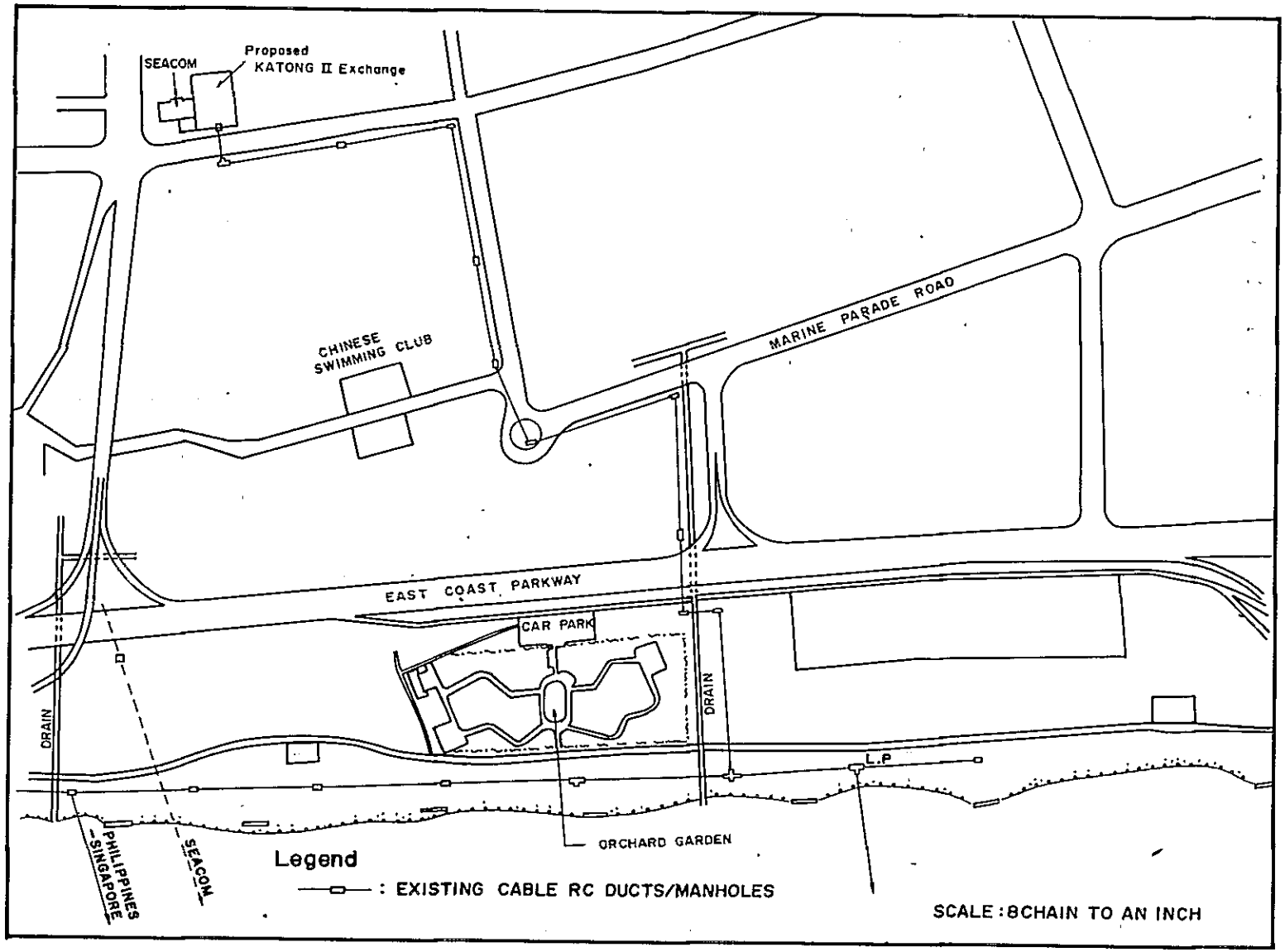


Fig. 3.5.20(a) BEARING OF CABLE ROUTE IN PECHABURI (BAN HAT CHAO SAMRAN)

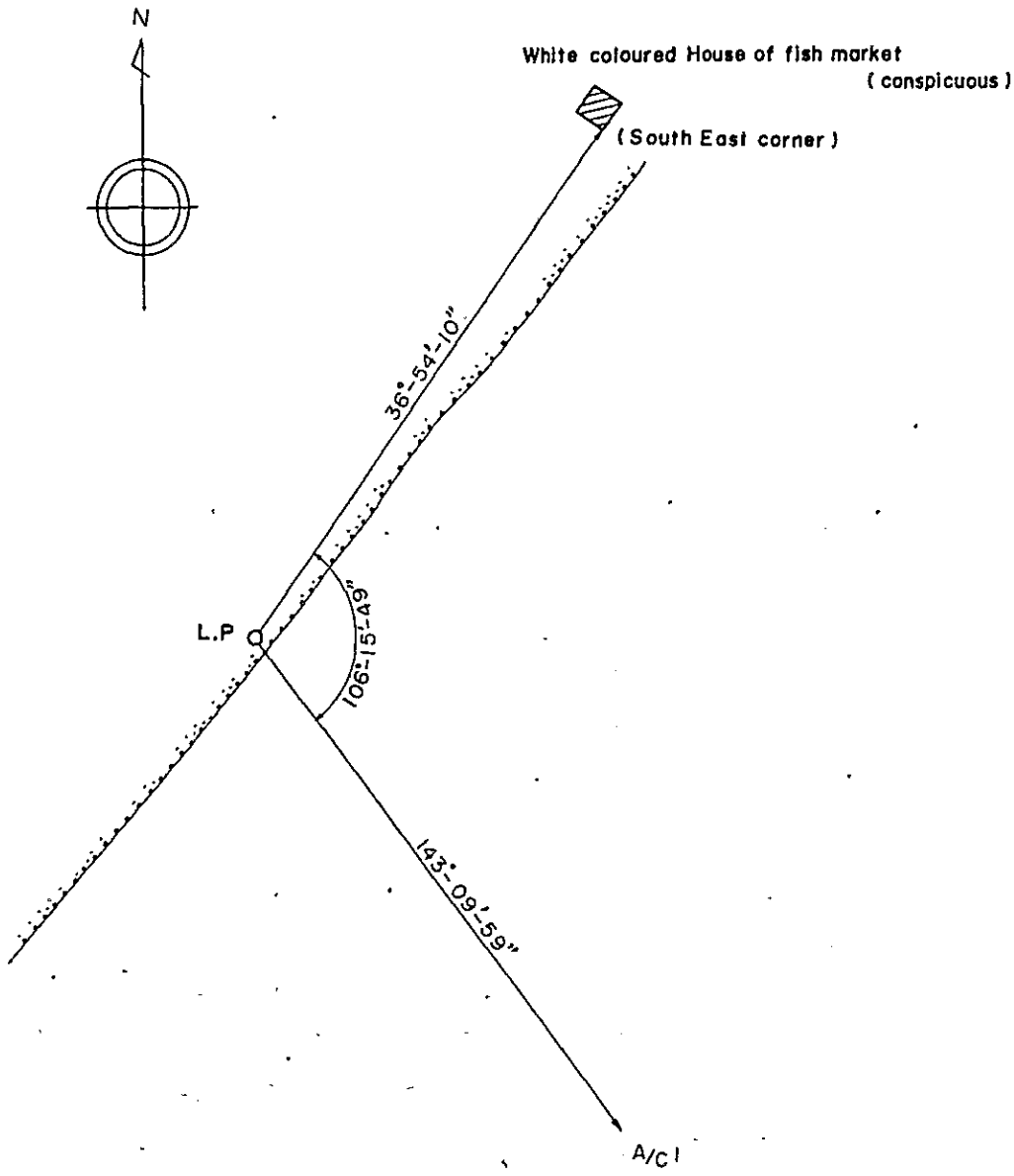


Fig.3.5.20(b) BEARINGS OF CABLE ROUTE IN KUANTAN

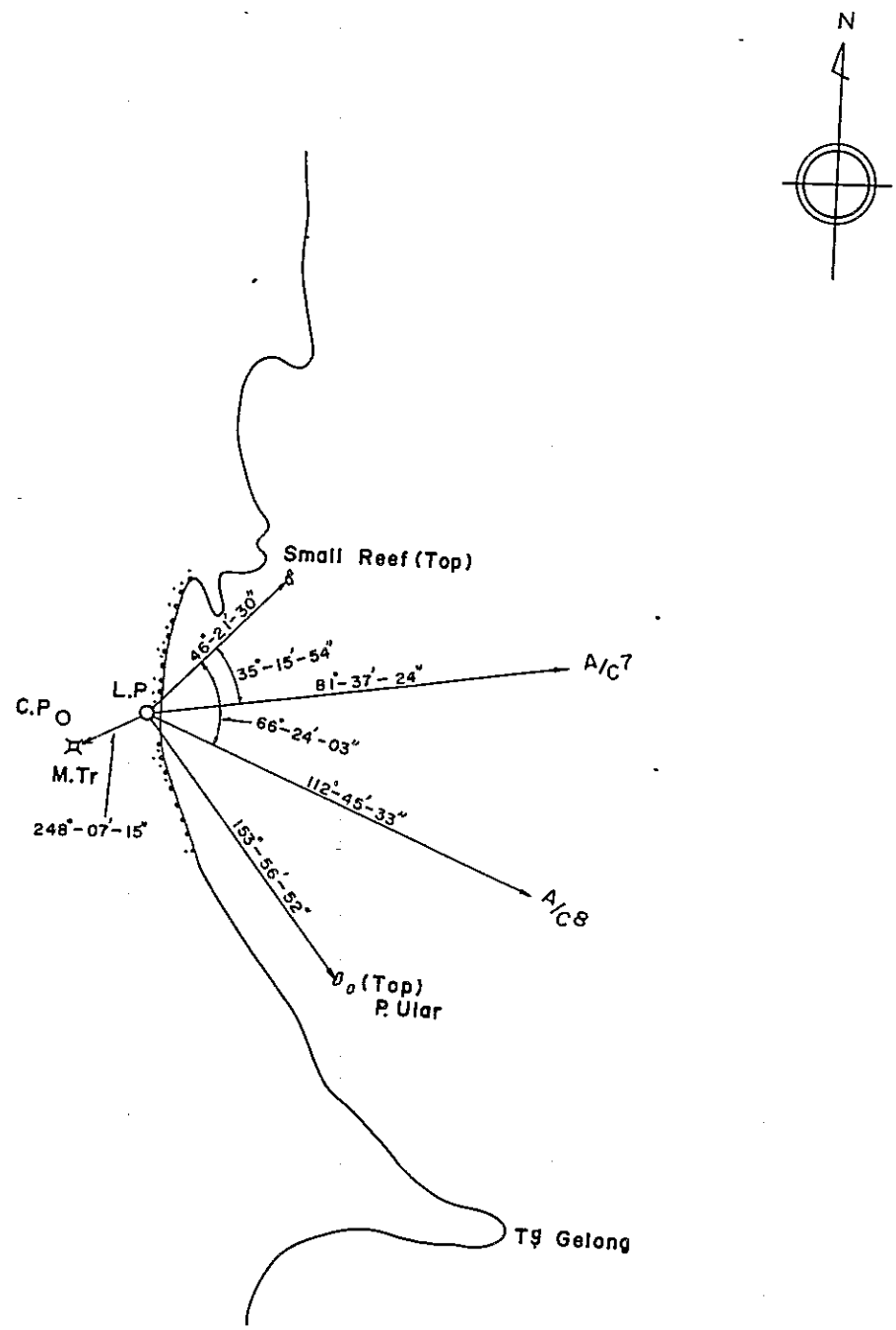
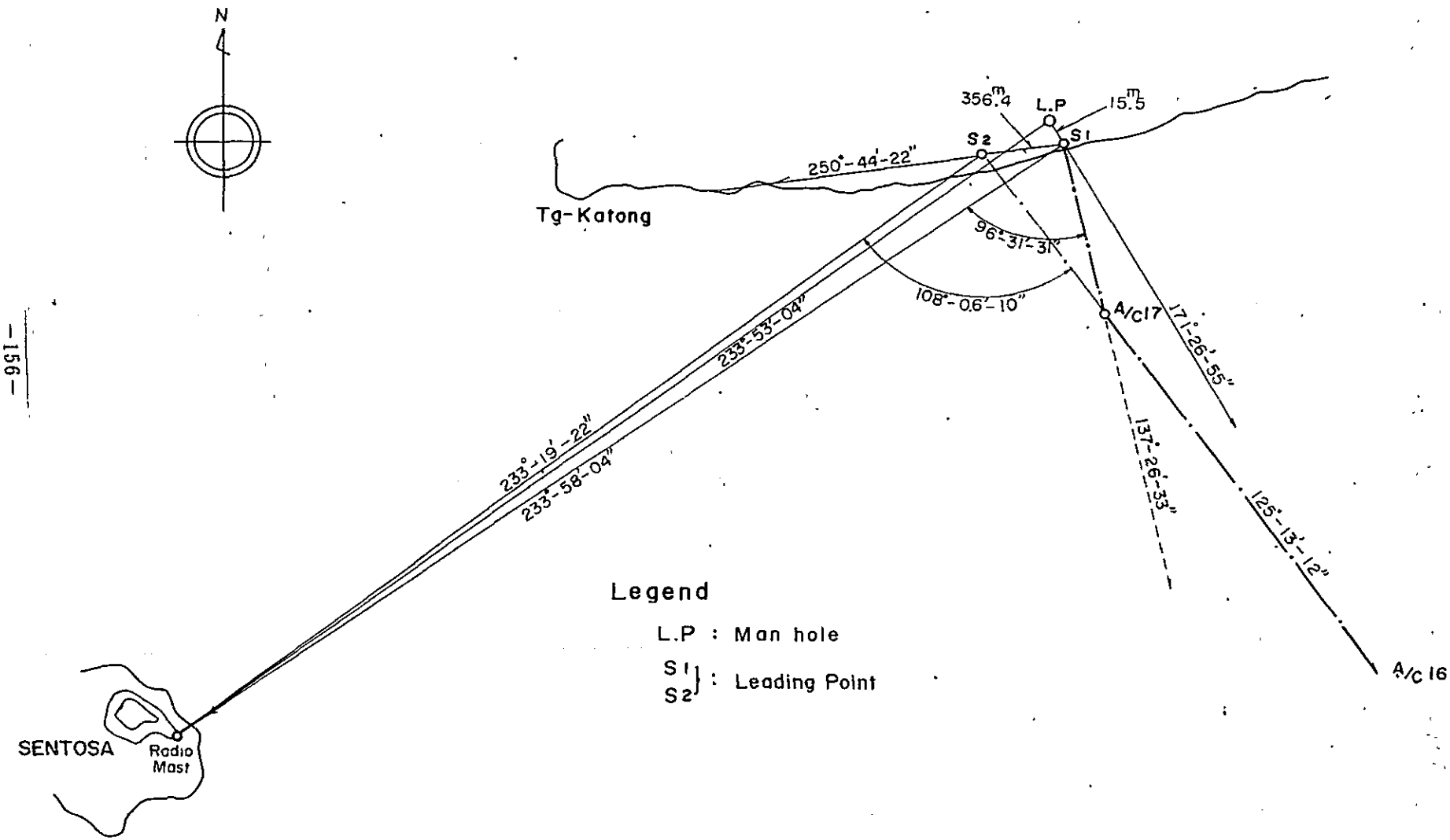


Fig. 3.5.20(c) BEARINGS OF CABLE ROUTE IN KATONG



3.5.9　海底資源開発

タイ湾中央部および南支那海南部のマレイシア沖海域には石油，天然ガスの開発鉱区が設定されている。タイ湾にはバンコック付近から湾の中央部を南下してソンクラに揚陸する海底パイプライン布設計画があり，バンコック付近の部分は既に着工されている。マレイシアのクアンタン沖１２０～１３０海里からソンクラにかけて拡がる開発鉱区にも海底パイプラインの計画があり，トレンガヌに揚陸することが予定されている。

海底ケーブルの調査ルートは，これ等鉱区やパイプラインを避けるためにパイプラインの西側に選定された。然し，陸揚げが予定されているパイプラインとの交差は不可避である。パイプラインの布設工事がケーブル布設工事より先行しない限り，布設されたケーブルはパイプライン工事のために切断を余儀なくされるであろう。このため，この交差点付近には予め余分の長さのケーブルを布設しておくのがよい。これにより，パイプライン埋設工事のために切断したケーブルの接続が容易になる。タイ湾のパイプライン計画およびクアンタン沖合の鉱区をそれぞれ　Appendix　4(a)及び(b)に示す

3.5.10　漁業活動

調査ルート海域における漁業は非常に盛んである。このことは調査期間中に目撃した漁船の操業状況，海域に仕掛けられた網漁具（トラップ或いは刺網の類と推測される）およびサイドスキャンソナの記録，その他，当海域の漁業に関する文献，資料等がこれを裏付けている。ケーブルに被害を与え得る漁具としては，底びきに使用するオッターボード，けた曳きに使用する爪等があり，以下，トロールについての調査結果を述べる。

(1)　トロールによるものと推定される海底表面の条痕

サイドスキャンソナーを使用しての海底表面探査記録に非常に多くのトロールによるものと推定される条痕が認められる。Table 3.5.3 は区間毎の条痕数をまとめたもので，Fig 3.5.21はこれをルート上に示したものである。

(2)　タイ国の漁業

１９６１年頃からタイ湾におけるトロールは急速に発展して年生産は急増し，タイ国海面漁業生産の７０％を占めるに至った（１９７１年現在）。トロール漁業が導入された1960年頃には漁獲は水深を増すにつれて低下し，水深２０m～３０mの水域での漁獲が最多であったが，沿岸の浅海を獲りつくして１９６０年代後半にはその状況が逆転した（Table 3.5.4）。然し，５０m以深の漁獲物は経済価値が低いので，タイ湾の漁場はいづれにせよ浅海域に限定されている。

Fig 3.5.22 および　Table 3.5.5 はタイ湾の調査漁区区分と漁獲量を示し，Table 3.5.6 はトロール漁船の構成を示す。

(3) マレイシア半島

半島マレイシアの海面漁業は，１９６５年にトロール漁法が導入されて以来漁獲量が急増し，１９５７年の年産量１１.３万トンが１９７１年には３２万トンに達している。

マレイ半島東岸では全海岸線に沿って漁業が行われているが，北東季節風の期間は大きく制約を受けている。

１９６５年～１９７１年における東岸の漁業生産は半島マレイシア総生産の２３％を占めると推定される。

東岸における漁場は沖合３０～４０海里で，漁法ははえなわ，刺網，トロールが主であり，操業する漁船数は約6,８００，うち5,４００隻が動力船である。また，漁船の大きさは大半が５０トン未満で，エンジン馬力も６０馬力以下のものが殆んどであるが，最大のものは２５０トン未満で馬力数１００～１２０馬力である。マレイシアは漁船の大形化と操業海域拡張の計画をもっている。マレイシアテレコムから提供を受けた資料を Table3.5.7に示す。

(4) シンガポールの漁業

シンガポールの漁業は産業構造の工業化に伴って著しい減少を示している。Table3.5.8に漁種別漁船数を示す　１９７１年に１３２隻であったトロール船は１９７２年には117隻となり，さらに漸減傾　　"っている。

Table 3.5.3 Number of Fishing Gear Traces

Stations	Grade
1 - 10	2
10 - 20	1
20 - 140	-
140 - 180	2
180 - 220	1
220 - 310	-
310 - 340	3
340 - 370	-
370 - 380	2
380 - 400	4
400 - 410	3
410 - 480	4
480 - 490	5
490 - 510	4
510 - 520	5
520 - 560	4
560 - 580	5
580 - 590	4
590 - 600	5
600 - 610	4
610 - 670	5
670 - 720	4
720 - 730	3
730 - 740	1
740 - 770	-
770 - 780	2
780 - 830	3
830 - 850	1
850 - 860	2
860 - 870	1
870 - 907	-

Grade	The Number of Fishing Gear Traces
1	1 - 3
2	4 - 15
3	16 - 63
4	64 - 255
5	256 -

Note: Number of traces are counted at every 10 stations.

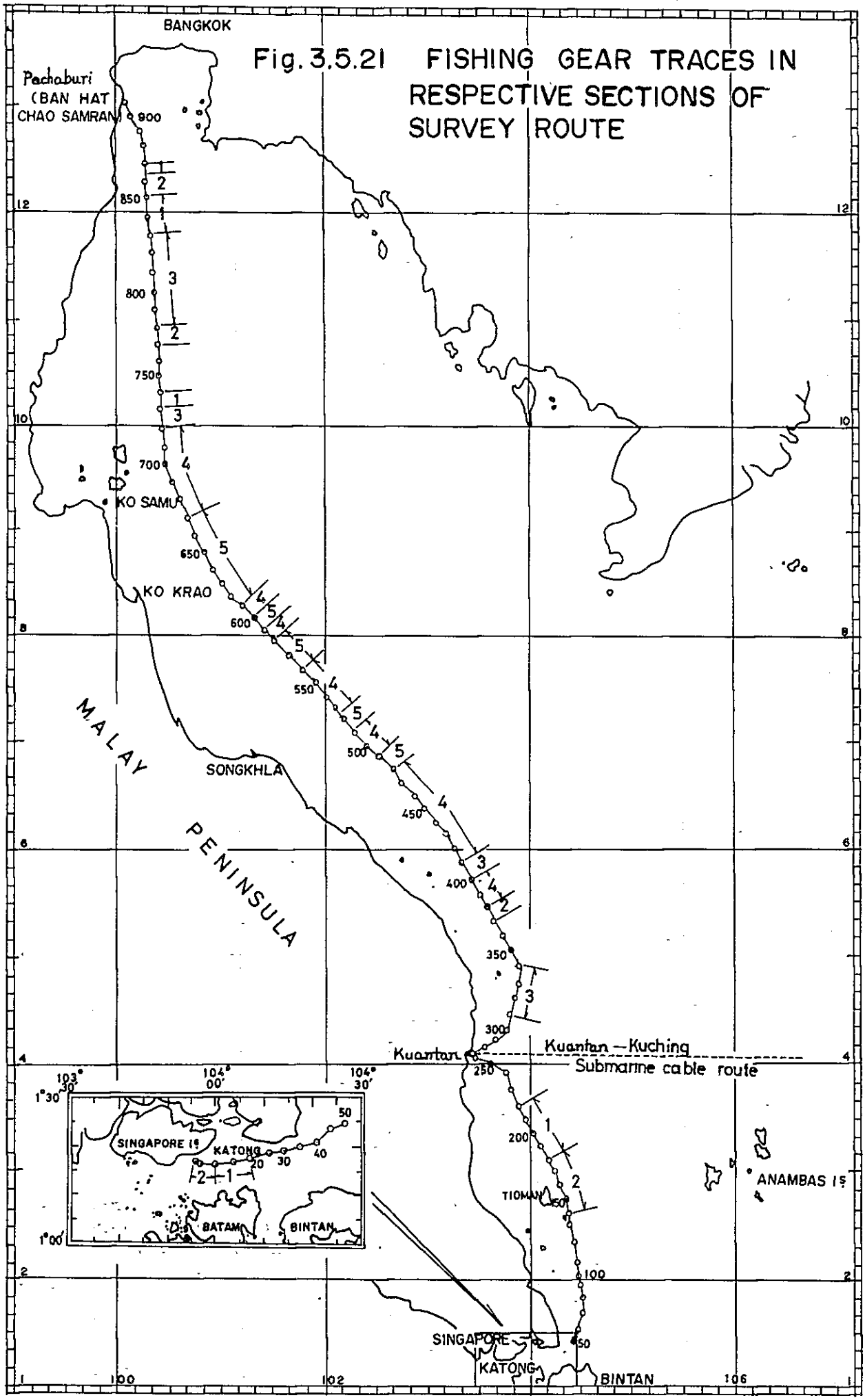


Fig. 3.5.21 FISHING GEAR TRACES IN RESPECTIVE SECTIONS OF SURVEY ROUTE
BANGKOK
Pachaburi
(BAN HAT
CHAO SAMRAN)
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
KO SAMUI
KO KRAO
SONGKHLA
MALAY PENINSULA
Kuantan
Kuantan—Kuching
Submarine cable route
TIOMAN
ANAMBAS IS
SINGAPORE
KATONG
BINTAN
BATAM
SINGAPORE IS
103° 30'
104° 00'
104° 30'
1° 30'
1° 00'
12
10
8
6
4
2
1
100
102
104
106

Table 3.5.4 Fish Catches (kg) per Hour by Trawling in Respective Depths in the Gulf of Thailand

Year	Depth				
	10∿19	20∿30	31∿44	more than 44	10∿44 or more
1966	107.19	127.51	144.72	134.80	130.77
1967	95.15	85.25	131.45	180.65	115.05
1968	88.96	98.99	109.16	131.66	105.92
1969	94.83	91.86	112.79	126.64	102.74
1970	102.76	82.68	110.92	103.00	97.44

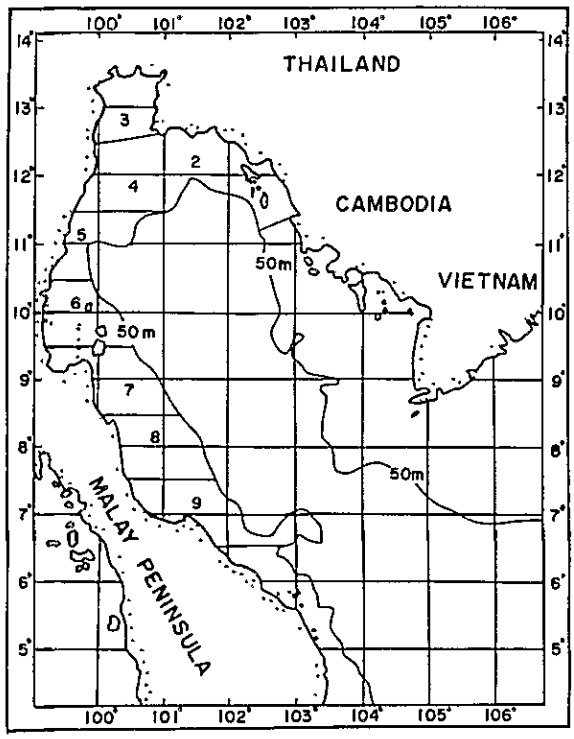


Figure 3.5.22 Fishing Area Sectioning in the Gulf of Thailand

Table 3.5.5 Trend of Fish Catch (kg) per Hour by Trawl in the Gulf of Thailand

Fishing Section	1963	1966	1967	1968	1969	1970	1971	1972
Section 1	341	113	107	66	51	82	33	49
2	230	58	41	55	64	49	30	40
3	264	109	95	68	74	52	46	55
4	260	153	87	72	90	96	70	77
5	201	139	151	100	122	122	80	98
6	286	137	91	187	114	99	76	60
7	190	121	101	93	113	130	97	73
8	247	183	182	172	148	130	75	59
9	212	165	180	142	149	117	82	58
Average	249	131	115	106	103	97	66	63

Table 3.5.6 Number of fishing boat registered by size and by Type of method in Thailand

Size & Year / Method	1975					1976				
	<14m	14-18	18-25	>25	total	<14m	14-18	18-25	>25	total
Other trawl	1,598	1,571	528	119	3,816	1,986	1,523	489	90	4,088
Pair trawl	112	379	356	5	852	104	358	366	4	832
Beam trawl	283	11	-	-	294	277	7	-	-	284
Thai purse seine	55	162	157	-	374	88	162	101	-	351
Chinese purse seine	-	11	7	-	18	-	9	8	-	17
Anchovy purse seine	17	21	2	-	40	37	20	1	-	58
Lurine purse seine	17	56	120	-	193	27	89	183	1	300
Spanish mackerel gill net	63	99	15	-	177	56	93	8	-	157
Pomfret gill net	2	3	-	-	5	11	2	3	-	16
Mackerel encircling gill net	155	32	-	-	187	180	41	5	-	226
Otter gill net	844	3	-	-	847	1,492	6	-	-	1,498
Push net	1,058	17	-	-	1,075	820	24	-	-	844
Luring lift net	-	2	-	-	2	-	1	-	-	1
Shrimp gill net	21	-	-	-	21	527	-	-	-	527
Long line	12	4	-	-	16	30	13	4	-	47
Other nets	46	-	-	-	46	97	1	-	-	98
Squid cast net	-	-	-	-	-	44	-	-	-	44
Total	4,283	2,371	1,185	124	7,963	5,776	2,349	1,168	95	9,388

Table 3.5.7 Fishing Activities in the Sea Area of the East Coast of Peninsular Malaysia

1. Fishing Grounds

i) The fishing grounds in the southern part of the South China Sea with numbers and types of fishing boats licensed in 1976 are as shown in the table below.

State / Type	Kelantan	Trengganu	Pahang	Johore East	Sub Total
a) Inboard	911	2430	758	930	5029
b) Outboard	102	9	24	232	363
c) Non-powered	181	571	131	613	1496
Total	1194	3006	913	1775	6886

ii) Number of fishermen working in licensed boats.

State	Kelantan	Trengganu	Pahang	Johare East	Sub Total
	4834	11,875	3668	5402	25,779

2. Main Fishing Ports and Vessels

i) Main fishing ports around pertinent areas as follows:

Fishing Port	Total No. of Fishermen	Total No. of Vessels
Johore Bahru	2718	1127
Kota Tinggi	2523	1103
Mersing	2879	672
Kuantan	1771	399
Pekan	1083	288
Kemaman	2164	525
Dungun	1826	478
Marang	1184	239
Kuala Trengganu	3918	1089
Besut	2783	665
Kota Bahru	3444	794
Bachok	1320	400

ii) Number of fishing gears at the East Coast:

State	Kelantan	Trengganu	Pahang	East Johore	Sub Total
Trawl nets	180	436	343	317	1276
Seine nets	52	299	81	97	529
Drift/Grill nets	340	488	205	435	1468
Lift nets	29	23	37	58	217
Traps a) stakes	563	-	12	100	675
b) portable	33	188	138	51	410
Bag nets	-	-	2	267	269
Lines	-	1393	253	22	1668
Barrier nets	-	-	-	28	28
Push nets	-	-	-	-	-
Shell fish	-	-	-	-	-
Miscellaneous	-	-	-	-	-
Total	1197	2897	1071	1375	6540

iii) Sizes, types and powers of fishing vessels:

a) Inboard powered fishing boats

Description	Kelantan	Trengganu	Pahang	East Johore	Total
(Dimension-length) under 25 ft.	233	184	25	86	528
25 - 39	492	1670	547	483	3192
40 - 54	157	512	169	284	1122
55 ft. and over	29	44	17	77	167
Total	911	2410	758	930	5009
(Tonnage) ∿4.9 tons	374	431	133	274	1212
5 - 9.9	243	1095	384	205	1927
10 - 14.9	143	573	103	92	911
15 - 19.9	63	167	26	43	299
20 - 24.9	27	61	12	59	159
25 - 49.9	53	103	95	174	425
50 - 99.9	7	-	5	3	15
100 - 249.9	1	-	-	-	1
Total	911	2430	758	930	5029

3. Fishing areas are about 30∿40 miles offshore.

4. Typical means of fishing are as follows.

a) Trawling

b) Traps

c) Pursening

5. Main base

a) Kuala Sedili (Johore)

b) Nersing

c) Kuantan

d) Chendering

e) Kuala Besut

6. The total number of vessels around the East Coast summarized from the above table is about 6800.

Table 3.5.8 Number of Fishing Boats Engaged in Respective Fishing Activities

	1950	1955	1968	1969	1970	1971	1972
No. of Powered Boats	642	665	1250	480	750	580	535
No. of Non-powered Boats	2402	2209	1335	363	425	221	241
Trolling	150	125	101	-	84	89	77
Longlines (inshore)			53	26	23	-	-
Longlines (offshore)			9	10	12	11	11
Other hook and lines			-	-	-	70	63
Set barriers	28	25	18	11	8	0	0
Filter nets, prawn	271	285	60	49	42	-	-
Traps & pots, (shallow)	195	170	39	22	11	-	-
Traps & pots, (deep)			36	15	24	14	12
Traps & pots, (coral)			15	12	17	-	-
Palisade traps	408	479	272	246	226	200	200
Lift nets	87	78	19	7	6	-	-
Drive-in nets	4	4	-	-	-	-	-
Gill nets	483	485	408	273	260	218	211
Beach seines	104	97	42	18	25	10	8
Purse seines	1	-	1	1	-	-	-
Bag nets	1	7	-	-	-	-	-
Otter trawls	0	0	85	97	118	132	117

3 6　検討および結論

3.6.1　ケーブルルートと所要ケーブル長

調査結果から，調査ルートの主側線はそのまゝケーブル布設ルートとしてよい。この布設ルートはFig 3.2.1 及び　Table3.2.1 に示すとおりである。然し，この布設ルートは平均水深４０～５０ｍの浅い海域にあるためケーブル保護対策が必要である。

ケーブルスラックは１％を見込めば充分であろう。従って，各陸揚地での陸上部ケーブル長を含まない陸揚基準点間を結ぶ所要ケーブル長は次のとおりとなる。

- ペチャブリ～クアンタン：６２７.９㎞（ 1.１６２.９Km ）
- クアンタン～カトン　　：２２２.２㎞（　４１１.５Km ）
- 全区間　　：８５０.１㎞（ 1.５７４.４Km ）

前記3.5.9項で述べた海底ガスパイプラインとの交差に伴って準備しておくケーブル余長は，交差部分毎に，最低，水深の２倍程度必要である。そしてこの余長は上記所要ケーブル長に含まれている。

3.6.2　ケーブル障害対策

世界の海底ケーブルの障害のうちの大部分は，　Table3.6.1 に示すように主として漁撈および投錨によって発生している。海底ケーブルを漁業，投錨等の人為障害から保護することについては，１８８４年に締結された万国海底電線保護条約がある。然し，条約あるいは規定によってケーブルルート上の漁業活動，船舶の投錨を規制することは非常に困難であり，従来は自衛手段として専ら外装ケーブルが使用されていた。

然し乍ら，外装ケーブルはこれら人為障害に対して必ずしも充分な効果は期待できず，このことは前記，　Table3.6.1 が物語っている。

最近に至り，より効果的なケーブル保護策としてケーブル埋設技術が開発され，　Table 3.6.2 に示すように世界の主要海底ケーブルの浅海部分に実用されている。特に，１９７６年に完成した日本～中国間海底ケーブルは漁業活動の極めて盛んな東シナ海に布設され，全長８５０Kmのうちその８０％に当る６８０Kmが埋設され，その埋設距離の点で他に類を見ない海底ケーブルシステムである。完成後２年を経た現在，１件の障害もなく，通信サービスの高信頼性を示している。この日中ケーブルは，ＫＤＤが開発した多段鋤式埋設機によって埋設されたものである。

これら漁撈，船錨からケーブルを保護する手段としてケーブルを埋設する場合，漁具による海底堀削深度，船錨の海底下貫入深度よりも深くケーブルを埋設すればよい。Fig 3.6.1 は漁具，船錨の底質に応じた貫入深度を示す。

例えば，１トンの船錨は軟かい底質では約１ｍ貫入する。このような大形の船錨からケーブルを物理的に保護することは至難の業である。然し，大形船の場合は前述の法的規制による効果が零細な小形漁船の場合に比して期待できる。従って１００トン程度の小形船が通常使用する２００Kg級の船錨および漁具による貫入度を考慮すると，Fig. 3.6.1から軟かい底質でケーブルは５０cm～６０cm埋設すればよいことが分る。また，底質による漁具等の貫入深度とケーブル埋設機の埋設深度とは相対的関係にあり，底質が硬くてケーブル埋設深度が充分得られないところは漁具等の貫入深度もまた浅いことも留意すべきである。

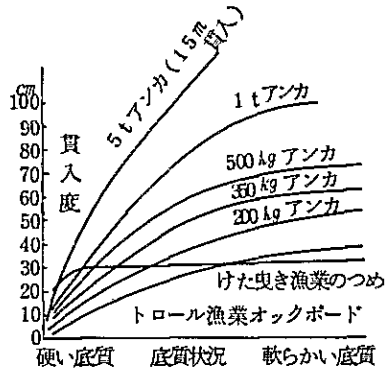


図3.6.1
漁具，船錨の海底底質による貫入度

調査結果から，調査海域における漁業活動は盛んであり，漁船の大型化や操業海域の拡張が計画されている（前記3.5.10章参照）。また，ケーブルルートが岸に近く，水深が総じて浅いため，船舶の投錨も不可避と考えねばならないであろう。

このため，ケーブル保護の手段としてケーブル埋設が最適であると判断される。

一方，ケーブルルートのうちのある部分には埋設効果が充分に期待できないと推測されるところがある。即ち，ペチャブリ斜面からタイ湾平坦部までの底質は，粘土が主であるがよく締っていて硬く，埋設には困難が予想される。クアンタン斜面からマレイシア南東部沖にかけては，一部にサンドウエーブや砂漣が観測されている。また，シンガポール海峡部は潮流が早く，海底地形は全ルート中最も起伏が激しく，顕著な砂漣の存在に特色づけられている。このようなところでは漂砂の移動が繰返されていると推定されるので，埋設時の条件によっては，埋設されたケーブルが露出したり，ケーブル外被と砂との摩擦が繰返されることがあるかも知れない。

このような埋設が困難なところや，埋設効果の期待薄の部分については，次善策として外装ケーブルを使用すべきである。また，同時に漁船その他の船舶に対して充分な注意を換起する手段を講ずることが望ましい。

以上の調査および検討結果を踏まえ，海底ケーブルを漁撈，投錨および漂砂等から保護し，通信サービスの信頼性を確保するために，全区間ケーブル埋設を行い，その埋設見込深度に応じて無外装，外装ケーブルを使い分けることを勧告する。その場合の使用ケーブル区分の一例を Appendix 5に示す。

Table 3.6.1 Analized Submarine Cable Failures in the Period of September 1953 to November 1964

	Cause of Failure	%
1	Trawlers & ship anchors	44.0
2	Biological & chemical damage	4.0
3	Corrosion or chafe damage	27.0
4	Earthquake related damage	1.6
5	Iceberg damage	1.6
6	Damaged by re-routing or preventative maintenance	8.3
7	Miscellaneous failures (tension, twist, crash, electrical faults, etc.)	13.5

Ref.: Bell Telephone System Technical Pub. 5203
"Analizing Failures of Ocean Communication Cables"
by A.J. Munitz

Table 3.6.2 Buried Submarine Cables in the World

Cable System	Time	Buried Distance (km)	Sea Depth (m)
TAT-4	Jul. 1967	68	54 - 152
TAT-3	Jul. 1967	88	42 - 134
SF-FLORIDA	Apl:∿May 1968	68	16 - 40
TAT-5	Jul. 1969	164	18 - 540
TAT-5	Aug. 1969	53	22 - 558
MAT-1 (Spain)	Aug. 1969	20	40 - 600
MAT-1 (Italy)	Sep. 1969	28	16 - 600
CANTAT-2 (Canada)	Nov. 1973	222	less than 550
CANTAT-2 (U.K)	Apl. 1973	Unknown	less than 550
TAT-6 (Rhode Island)	Aug. 1975	176	less than 180
TAT-6 (France)	Oct. 1975	176	less than 180
Japan - China	Apl.∿May 1976	680	less than 200

Ref.: IEEE Transaction Courm, Technology Vol. COM-19, No.6 1971, Electrical comm. Vol. 49, No.4 1974, BTL Record Sep. 1976, ITU Telecommunication Journal July 1977

4. References

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  1) "Current in the South China, Java, Celebes and Sulu Sea," published by the Hydragraphic Office United State Navy, 1945
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付　　録

APPENDIX

SUMMARY OF DISCUSSIONS
ON
THE ROUTE SURVEY OF THE ASEAN SUBMARINE CABLE PROJECT
(THAILAND-MALAYSIA-SINGAPORE ROUTE)
BETWEEN THAILAND AND JAPAN

The Japanese Preliminary Study Team for the ASEAN Submarine Cable Project (Thailand-Malaysia-Singapore Route) and the representatives of the Post and Telegraph Department, the Communications Authority of Thailand, Ministry of Communications met at the office of PTD on February 28, 1978, and discussed on the scope of works and other related matters of the route survey to be carried out by the Japanese International Cooperation Agency under the agreement between the Governments of Thailand, Malaysia, and Singapore, on one hand, and the Government of Japan on the other hand.

The discussions have brought about a "Scope of Work for the Route Survey" (Annex I) and "Supplementary Note to the Scope of Work in Thailand" (Annex II) which attached hereto together with the list of attendants (Annex III) to the discussions.

In the course of discussions the Thai side requested that subject to result of the consultations to be held with the authorities of Malaysia and Singapore, the Japanese team would review the proposed time schedule of the route survey, ...2/

in order that a final report be submitted to the three governments concerned earlier then proposed, if possible by the end of August or September, 1978.

The Japanese side stated in reply that interim report contains all necessary and sufficient information for inviting tenders for construction and that while it will be much difficult to prepare the final report earlier than originally proposed, it will keep in mind the request of the Thai side in preparation of the final report.

(Annex I)

SCOPE OF WORK
FOR
THE ROUTE SURVEY
OF
THE ASEAN SUBMARINE CABLE PROJECT
(THAILAND-MALAYSIA-SINGAPORE ROUTE)

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Introduction

In response to the requests of the governments of Thailand, Malaysia and Singapore, the government of Japan has decided to conduct the route survey for the ASEAN submarine cable project (Thailand-Malaysia-Singapore Route) as a part of its technical cooperation programmes to foreign countries.

Based on this decision, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the cooperation programmes has organized a team so as to carry out the survey.

The present document sets forth the scope of work in regard to the above mentioned survey which is to be carried out in close cooperation with the governments and authorities concerned.

2. Objective of the survey

The objective of the survey is to select the most suitable route for laying a submarine cable which links the cable landing sites in Thailand, Malaysia and Singapore and to provide these three countries with necessary data for designing and laying the submarine cable system.

3. Outline of survey work

The ocean survey will be made by using a Japanese survey vessel "DAISAN KAIKO MARU" (500t) on the following items.

1) Sounding
2) Subbottom profiling near the bottom surface
3) Observation of bottom surface condition by using Side Scan Sonar and underwater camera
4) Sampling bottom sediment
5) Observation of water temperature

Survey of the land portion from landing point to cable terminal site will also be made, if necessary.

4. Report

4.1 Preparation of report

JICA will prepare and submit required number of copies of the following reports in English to the three governments.

1) Interim report

   Within about two weeks after the completion of the ocean survey.

2) Draft final report

   Within about three months after submission of interim report. The governments concerned are requested to provide with their comments on the draft final report within two weeks after receiving the report from JICA.

3) Final report

   Within two months after receiving comments from the governments concerned.

4.2 Contents of report

The report will contain the following items.

1) Interim report

   a. Summarized result of the ocean survey

   b. Proposed cable route and route conditions

   c. Cable length required for the proposed route and other requirements for designing the cable system

2) Draft final report and final report

   a. Descriptions on survey method and equipment used

   b. Result of the ocean survey

   c. Proposed cable route and route conditions

   d. Cable length required for the proposed route and other requirements for designing the cable system

   e. Some data or informations for cable laying operation

5. Undertaking of the governments of Thailand, Malaysia and Singapore

1) To provide the survey team with data and information necessary for the survey.

2) To exempt the team from the taxes and duties on the material or equipment associated with the survey and on the personal effects brought into the countries by the team.

3) To assign the official counterparts during the ocean survey.

4) To make necessary arrangements for the team to bring out data or materials relating to the survey to Japan.

5) To grant necessary approvals for the implementation of the ocean survey in the territorial waters.

6) To give necessary notice to fishermen and other people working in the survey area and to take appropriate measures so that the survey work may be carried out without any hindrances.

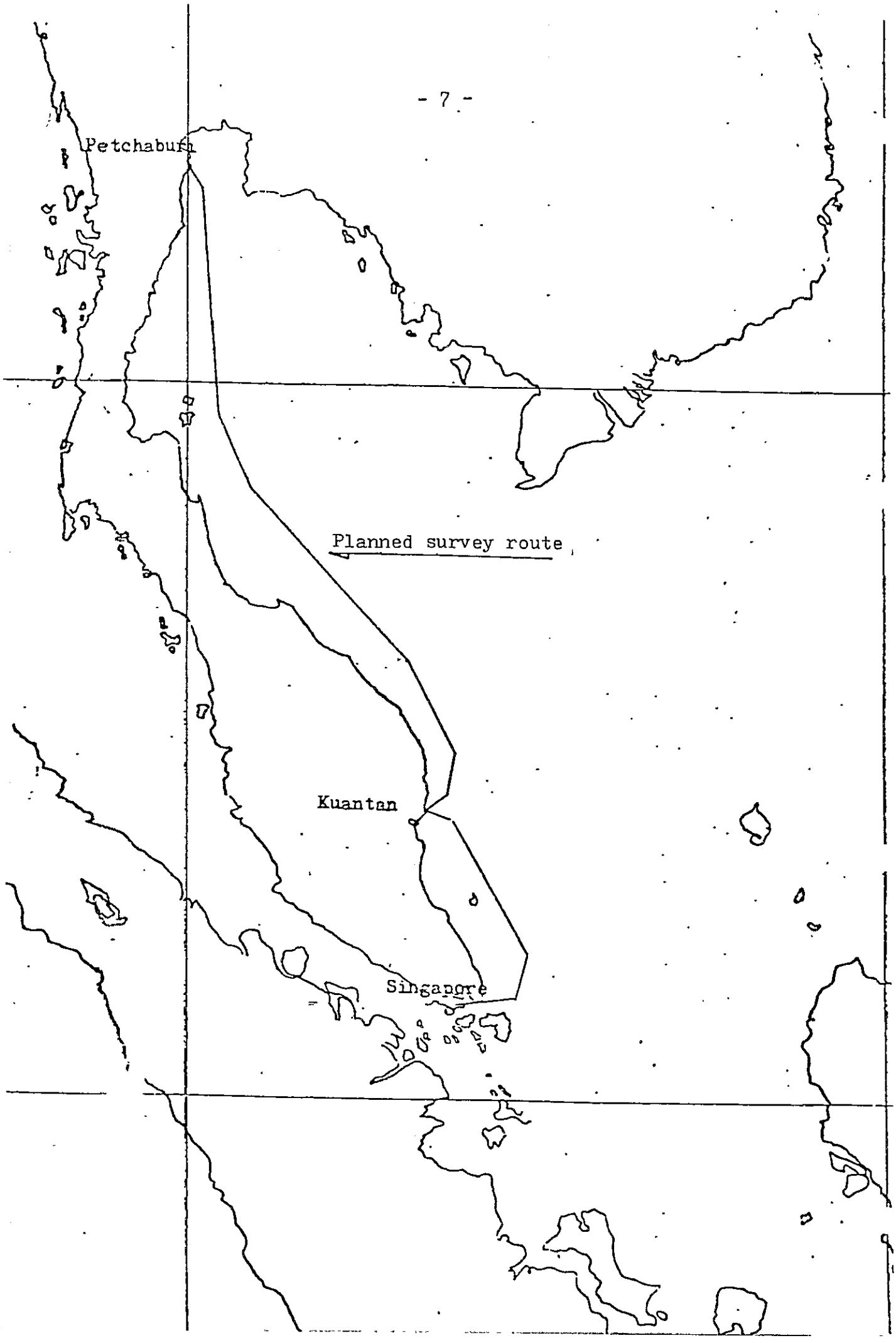
6. Schedule of survey

Refer to the attached paper

Time schedule of the route survey

Item \ Month	1978 2	3	4	5	6	7	8	9	10	11	12
Preliminary Study											
Preparation											
Ocean Survey											
Preparation and Submission of Interim Report											
Preparation of Draft Final Report											
Presentation and Discussion of Draft Final Report											
Preparation and Submission of Final Report											

Remarks: Work on the site


Petchaburi
Planned survey route
Kuantan
Singapore

(Annex II)

Supplementary note to the Scope of Work in Thailand

1. Details of work

(1) Ocean survey off the coast of Thailand will be made along the survey route roughly shown in the separate paper.

Survey route off the coast of Malaysia and near Singapore is subject to change according to the result of meetings with the governments of Malaysia and Singapore.

(2) Land portion of the submarine cable route which covers the area between cable landing point on the beach and the site for cable terminal building will be surveyed to clarify its position, distance and ground level along the route.

(3) The beach landing point will be selected in the vicinity of 12^{o} - 59.5N/100^{o} - 03.5E near Ban Hat Chao Samran.

(4) Land survey will be made by some of the survey team members who will go ashore by boat lowered from the survey ship.

The site for cable terminal building will be determined by Thailand authority concerned by the time of the cable route survey.

(5) Cable route conditions necessary for designing and laying the submarine cable system will be clarified in the final report basing upon the result of the cable route survey and informations given by Thailand authorities concerned

(6) Land survey will be made basing upon the fundamental points, if easily available around the land survey area, of which exact position should be known as a result of land survey made in the past.

2. Arrangements for the survey work

The government of Thailand

(1) Will assign two officials as observers of the route survey work.

(2) Will assign some officials who know well of the boundaries of each landed properties in the land survey area and assist the survey team in selecting the land cable route during the land survey.

(3) Will make necessary arrangement so that the survey team, observers and navigation crew on board the survey ship may go through due formalities off the cable landing shore, where the survey ship will stay for several days while the shore survey is made by the team. Passenger and crew list will be sent to the Thai government in advance. The ship schedule or ETA will be kept informed in the course of survey.

(4) Will provide the survey team with maps of large scale in advance of the land survey work.

(5) Will give survey team informations of obstacles, if any, around the survey route in the sea such as explosives, facilities for exploration work, etc in advance of the ocean survey.

3. Informations necessary for the preparation of report

The Government of Thailand will provide the survey team with following informations which will be useful for judging the route conditions

(1) Fishing activities in the Gulf of Thailand

(a) Main fishing ports and fishing grounds.

(b) Number of fishing vessels and size and engine power of biggest type of fishing vessels,

(c) Fishing methods. (with illustrations if available)

(d) Fishing activities in the future.

(2) Exploration activities for underwater resources

(a) Positions where explorations are made.

(b) Future plan of exploration.

(3) Existing data of the sea or sea bed such as seasonal water temperature variation, etc.

(Annex III)

List of Attendants to the Discussion

JAPAN

1. Yozo Kanemitsu (Leader)
   Ministry of Posts and Telecommunications (MPT)
2. Kunito Abe (MPT)
3. Hikaru Chono (MPT)
4. Teruo Shibata
   Kokusai Denshin Denwa Co., Ltd.(KDD)
5. Rokuro Kitsuta (KDD)
6. Taisuke Kitamura (KDD)
7. Akio Itoh
   Japan International Cooperation Agency (JICA)
8. Eiichi Furukawa
   Embassy of Japan
9. Hitoshi Ikeda
   Embassy of Japan
10. Ryo Suwa
    Bangkok Office, JICA.

THAILAND

1. Mr. Mahidol Chantrangkurn (Leader)
   Post and Telegraph Department (PTD)
2. Mr. Sudhorn Limpisthien (CAT)
3. Mr. Pol Kruatrachue (PTD)
4. Mr. Kitti Yupho (PTD)
5. Mr. Preecha Boonprasert (CAT)
6. Mr. Phongsakdi Potsiri (CAT)
7. Mr. Kittin Udomkiat (CAT)
8. Mr. Thosporn Simtrakarn (CAT)
9. Mr. Suthin Susila (DTEC)
10. Mr. Kamrop Varachart
    Ministry of Communications
11. Miss Nuannapha Thiencharoen
    Ministry of Communications

REPORT OF MEETINGS ON THE SCOPE OF WORK FOR THE ROUTE SURVEY OF SUBMARINE CABLE THAILAND-MALAYSIA-SINGAPORE

REPORT OF MEETINGS ON THE SCOPE
OF WORK FOR THE ROUTE SURVEY
OF SUBMARINE CABLE
THAILAND-MALAYSIA-SINGAPORE

At the request of the Governments of Thailand, Malaysia and Singapore, for technical aid to carry out a survey of Submarine Cable route from Thailand-Malaysia-Singapore, the Government of Japan, through Japanese International Cooperation Agency (JICA), despatched preliminary survey team headed by Mr. Kunito Abe, Vice Councellor of Telecommunications, Ministry of Posts & Telecommunications, to discuss the scope of work to be undertaken by the Government of Japan on the requirement for the survey of the proposed Submarine Cable routes.

Three meetings were held between the Japanese delegations and the Malaysian officials. They were held at the following venues:-

(i) March 3rd. 1978 at Telecoms Headquarters, Kuala Lumpur
(ii) March 7th. 1978 at Telecoms Headquarters, Kuala Lumpur
(iii) March 7th 1978 at The Economic Planning Department, Kuala Lumpur

The list of delegate attending the above meetings appeared in Annexes A, B & C.

The agreed Scope of Work for the Route Survey appeared as in Annex D. It is agreed that one officer from Malaysia shall participate in the survey work. The proposed route for the survey appears as in Annex D. The Malaysian officials requested that the temperature and current variation measurements/data to be included in the Interim Report. The Japanese delegations agreed to the requests.

The Malaysian officials agreed to provide the following information prior to the commencement of the ocean survey scheduled in the middle of April 1978:

(a) Fishing activities in the Malaysian Territorial Waters.
(b) Exploration activities for under water resources
    (i) Positions where explorations are made,
    (ii) Future plan of exploration,
    within 40 nautical miles from the Malaysian shoreline.

The schedule for submission of the Interim and Final Reports and their contents appear in Annex D.

Kuala Lumpur

Date: 8th March, 1978

(GOH KHEN KAH)
Director of Telecommunications
Kuala Lumpur

(KUNITO ADE)
Vice Counsellor of Telecommunications
Ministry of Posts & Telecommunications
Japan

ANNEX A

THE THAILAND-SINGAPORE-MALAYSIA SUBMARINE CABLE

PRELIMINARY SURVEY MEETING

TELECOMMUNICATIONS HEADQUARTERS, KUALA LUMPUR, MARCH 6TH, 1978

LIST OF DELEGATES

JAPAN	MALAYSIA
1. KUNITO ABE (Leader) Vice Counsellor of Telecommunications Ministry of Posts & Telecommunications	Ir HAJI MOHD ALI YUSOFF Controller of Telecommunications
2. HIKARU CHONO Ministry of Posts & Telecommunications	
3. TERUO SHIBATA Submarine Cable Construction KDD	
4. ROKURO KITSUTA KDD	
5. TAISUKE KITAMURA KDD	
6. AKIO ITOH Japan International Cooperation Agency (JICA)	

ANNEX B

THE THAILAND-MALAYSIA-SINGAPORE SUBMARINE CABLE

PRELIMINARY SURVEY MEETING

TELECOMMUNICATIONS HEADQUARTERS, KUALA LUMPUR, MARCH 7TH, 1978

LIST OF DELEGATES

JAPAN

1. KUNITO ANE (Leader)
   Vice Counsellor of Telecommunications
   Ministry of Posts & Telecommunications
2. HIKARU CHONO
   Ministry of Posts & Telecommunications
3. TERUO SHIBATA
   KDD
4. ROKURO KITSUTA
   KDD
5. TAISUKE KITAMURA
   KDD
6. AKIO ITOH (Coordinator)
   Japan International Cooperation Agency
   (JICA)
7. H.TSUJIMOTO
   Embassy of Japan
   Kuala Lumpur
8. TOORU KASAI
   Japan International Cooperation Agency
   Kuala Lumpur

MALAYSIA

I.O. MERICAN
Deputy Director General of
Telecommunications

GOH KHEN WAH
Director of Telecommunications

Ir HAJI MOHD ALI YUSOFF
Controller of Telecommunications

AHMAD SOBRI ISMAIL
Assistant Controller of
Telecommunications

ANNEX C

THE THAILAND-MALAYSIA-SINGAPORE SUBMARINE CABLE

PRELIMINARY SURVEY MEETING

ECONOMIC PLANNING UNIT, KUALA LUMPUR, MARCH 7TH, 1978

LIST OF DELEGATES

	JAPAN	MALAYSIA
1.	KUNITO ABE (Leader) Ministry of Posts & Telecommunications	BASHAH NORDIN Economic Planning Department
2.	HIKARU CHONO Ministry of Posts & Telecommunications	Ir HAJI MOHD ALI YUSOFF Telecommunications Department
3.	TERUO SHIBATA KDD	ZULKIFLIABU HASSAN Economic Planning Department
4.	ROKURO KITSUTA KDD	AHMAD SOBRI ISMAIL Telecommunications Department
5.	TAISUKE KITAMURA KDD	SAIKHOL ROSLI Economic Planning Department
6.	AKIO ITOH (Coordinator) Japan International Cooperation Agency (JICA)	
7.	TOORU KASAI Japan International Cooperation Agency Kuala Lumpur	

ANNEX D

SCOPE OF WORK
FOR
THE ROUTE SURVEY
OF
THE THAILAND-MALAYSIA-SINGAPORE SUBMARINE CABLE PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Introduction

In response to the requests of the governments of Thailand, Malaysia and Singapore, the government of Japar has decided to conduct the route survey for Thailand-Malaysia-Singapore submarine cable project as a part of its technical cooperation programmes to foreign countries.

Based on this decision, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the cooperation programmes has organized a team so as to carry out the survey.

The present document sets forth the scope of work in regard to the above mentioned survey which is to be carried out in close cooperation with the governments and authorities concerned.

2. Objective of the survey

The objective of the survey is to select the most suitable route for laying a submarine cable which links the cable landing sites in Thailand, Malaysia and Singapore and to provide these three countries with necessary data for designing and laying the submarine cable system.

3. Outline of survey work

The ocean survey will be made by using a Japanese survey vessel "DAISAN KAIKO MARU" (500t) on the following items.

1) Sounding

2) Subbottom profiling near the bottom surface

3) Observation of bottom surface condition by using Side Scan Sonar and underwater camera

4) Sampling bottom sediment

5) Observation of water temperature

Survey of the land portion from landing point to cable terminal site will also be made, if necessary.

4. Report

4.1 Preparation of report

JICA will prepare and submit required number of copies of the following reports in English to the three governments.

1) Interim report

Within about two weeks after the completion of the ocean survey.

2) Draft final report

Within about three months after submission of interim report. The governments concerned are requested to provide with their comments on the draft final report within two weeks after receiving the report from JICA.

3) Final report

Within two months after receiving comments from the governments concerned.

4.2 Contents of report

The report will contain the following items.

1) Interim report

a. Summarized result of the ocean survey

b. Proposed cable route and route conditions

c. Cable length required for the proposed route and other requirements for designing the cable system

2) Draft final report and final report

a. Descriptions on survey method and equipment used

b. Result of the ocean survey

c. Proposed cable route and route conditions

d. Cable length required for the proposed route and other requirements for designing the cable system

e. Some data or informations for cable laying operation

5. Undertaking of the governments of Thailand, Malaysia and Singapore

1). To provide the survey team with data and information necessary for the survey.

2) To exempt the team from the taxes and duties on the material or equipment associated with the survey and on the personal effects brought into the countries by the team.

3) To assign the official counterparts during the ocean survey.

4) To make necessary arrangements for the team to bring out data or materials relating to the survey to Japan.

5) To grant necessary approvals for the implementation of the ocean survey in the territorial waters.

6) To give necessary notice to fishermen and other people working in the survey area and to take appropriate measures so that the survey work may be carried out without any hindrances.

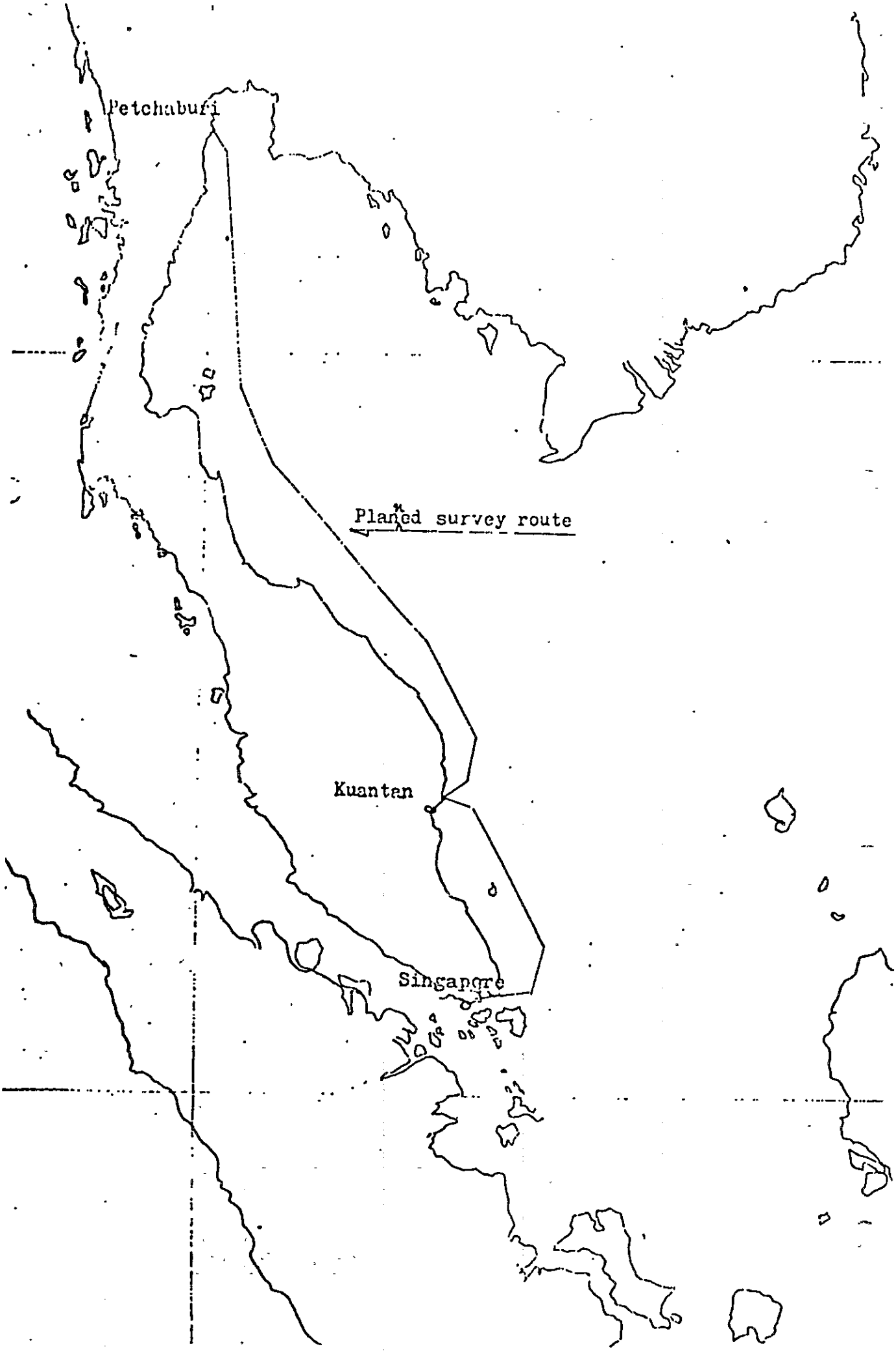
6. Schedule of survey

Refer to the attached paper.

Time schedule of the route survey

Item \ Month	1978 2	3	4	5	6	7	8	9	10	11	12
Preliminary Study											
Preparation											
Ocean Survey											
Preparation and Submission of Interim Report											
Preparation of Draft Final Report											
Presentation and Discussion of Draft Final Report											
Preparation and Submission of Final Report											

Remarks: Work on the site


Petchaburi
Planed survey route
Kuantan
Singapore

REPORT OF THE MEETING BETWEEN JAPANESE SURVEY TEAM AND TELECOMS ON THE ROUTE SURVEY OF THAILAND/MALAYSIA/SINGAPORE SUBMARINE CABLE 10 - 15 MARCH 1978, SINGAPORE

Introduction

1 A meeting was held between the Japanese Survey Team and Telecommunication Authority of Singapore (Telecoms) on the route survey for the Thailand/ Malaysia/Singapore Submarine Cable 10 - 15 March 1978, Singapore.

2 Mr Ng Hong Yew, Director of Corporate Planning, welcomed the delegates to the meeting.

3 The list of delegates is given in Annex I.

4 The approved agenda is given in Annex II.

1 Scope of Work

1.1 A paper on the scope of work for the Japanese Survey Team was tabled for discussion. The paper was adopted by the meeting. It is attached as Annex III.

1.2 It was confirmed that the report of the survey may be attached to the Tender Documents for information of the Tenderers.

2 Survey

2.1 A detailed survey work schedule was prepared and it is attached as Annex IV.

2.2 Telecoms requested that the shortest possible route should be chosen to achieve minimum cost.

2.3 Telecoms indicated that two representatives will be present for the survey.

3 Visit to Katong

3.1 A visit was made to the Katong landing point and the Katong Cable Station.

4.1 Telecoms provided the following information to the Japanese Survey Team.

(i) British admiralty chart 2403 and 3838 showing the routes of SEACOM, ASEAN PS and ASEAN IS Cable.

(ii) bottom water temperature-Singapore Continental Shelf.

(iii) bathymetric/sea bed feature chart and center-line profile chart of the Singapore Continental Shelf.

(iv) Katong plan showing landing point, beach manhole, cable duct.

(v) Port of Singapore Authority drawing GSP1 showing the anchorage area.

(vi) The coordinates of the sterilised cable corridor for cables landing at Katong.

(vii) PSA Singapore Tide Table and Port Facilities.

4.2 Should additional information be required the Japanese Survey Team would telex Mr Ma Chiu Tat Telecoms RS 21246.

Singapore

Date: 15th March, 1978

(Ng Hong Yew)
Director of Corporate Planning
Telecommunication Authority
of Singapore

(Kunito Abe)
Vice Counsellor of
Telecommunications
Ministry of Posts &
Telecommunications
Japan

ANNEX I

LIST OF DELEGATES

JICA

Messrs Kunito Abe
Hikaru Chono
Teruo Shibata
Rokuro Kitsuta
Taisuke Kitamura
Akio Itoh
Kikuo Sakamoto

TELECOMS

Messrs Ma Chiu Tat
Yan Man Fong
Alan Wong Kwok Wai
Wong Yau Liong
Tang Hoe Ming
Lo Loke Yee
Siew Ying Oak

ANNEX II

AGENDA

1 Scope of work.

2 Route survey.

3 Site visit to Katong landing point and Katong Cable Station.

4 Exchange of views and data on the proposed cable route and the routing of exisiting cable.

5 Any other business.

ANNEX III

SCOPE OF WORK
FOR
THE ROUTE SURVEY
OF
THE THAILAND-MALAYSIA-SINGAPORE SUBMARINE CABLE PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Introduction

In response to the requests of the governments of Thailand, Malaysia and Singapore, the government of Japan has decided to conduct the route survey for Thailand-Malaysia-Singapore submarine cable project as a part of its technical cooperation programmes to foreign countries.

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4.2 Contents of report

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a. Descriptions on survey method and equipment used

b. Result of the ocean survey

c. Proposed cable route and route conditions

d. Cable length required for the proposed route and other requirements for designing the cable system

e. Some data or informations for cable laying operation

5. Undertaking of the governments of Thailand, Malaysia and Singapore

1). To provide the survey team with data and information necessary for the survey.

2) To exempt the team from the taxes and duties on the material or equipment associated with the survey and on the personal effects brought into the countries by the team.

3) To assign the official counterparts during the ocean survey.

4) To make necessary arrangements for the team to bring out data or materials relating to the survey to Japan.

5) To grant necessary approvals for the implementation of the ocean survey in the territorial waters.

6) To give necessary notice to fishermen and other people working in the survey area and to take appropriate measures so that the survey work may be carried out without any hindrances.

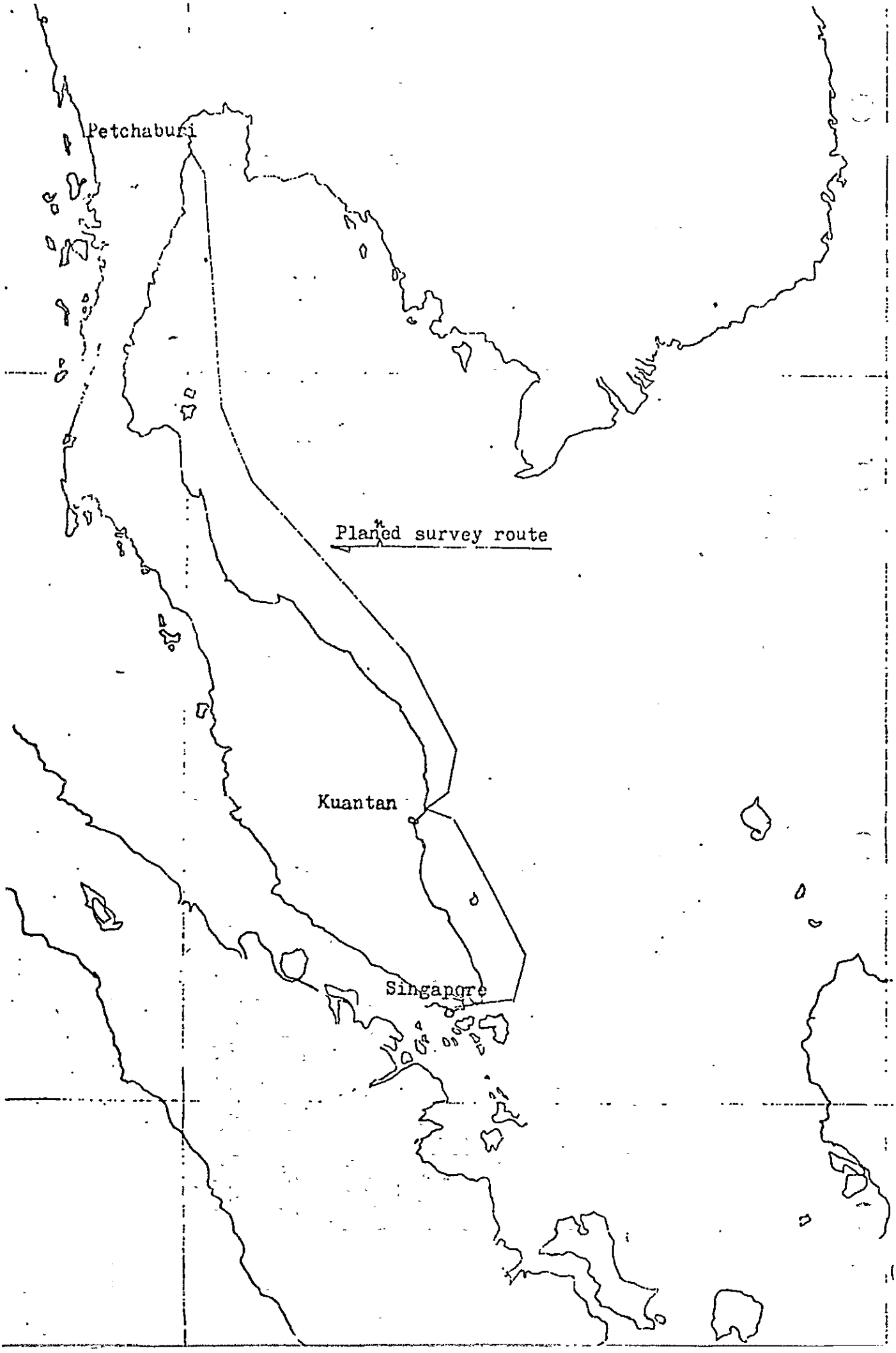
6. Schedule of survey

Refer to the attached paper.

Time schedule of the route survey

Item \ Month	1978 2	3	4	5	6	7	8	9	10	11	12
Preliminary Study	▨										
Preparation		▭	▭								
Ocean Survey			▭	▨	▭						
Preparation and Submission of Interim Report					▭						
Preparation of Draft Final Report					▭	▭	▭	▭			
Presentation and Discussion of Draft Final Report								▨			
Preparation and Submission of Final Report									▭	▭	

Remarks: ▨ Work on the site

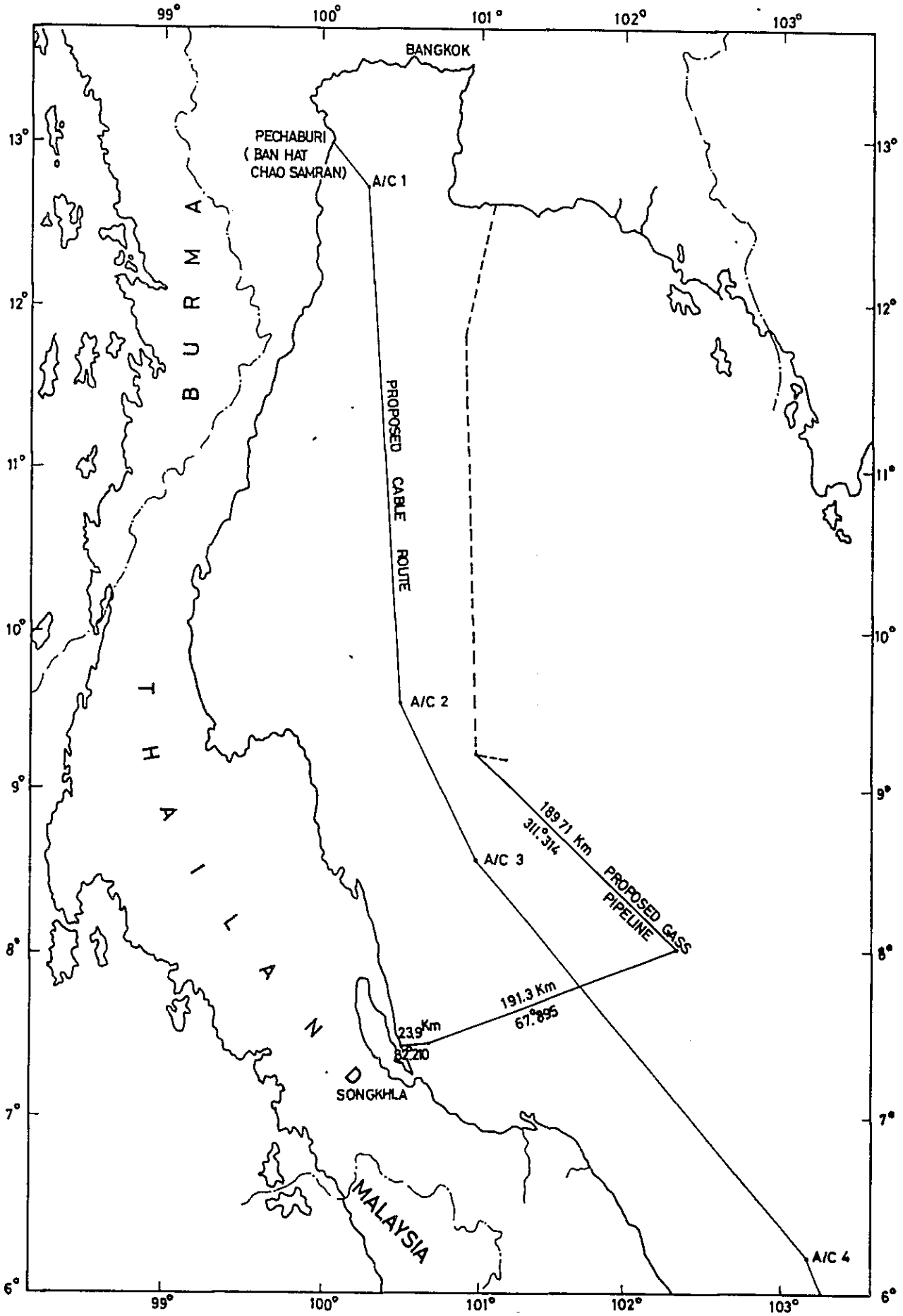

Petchaburi
Planed survey route
Kuantan
Singapore

ANNEX IV

SURVEY WORK SCHEDULE

The work shall be initiated immediately after the survey team and observers join the ship on the next day of ships arrival in Singapore.

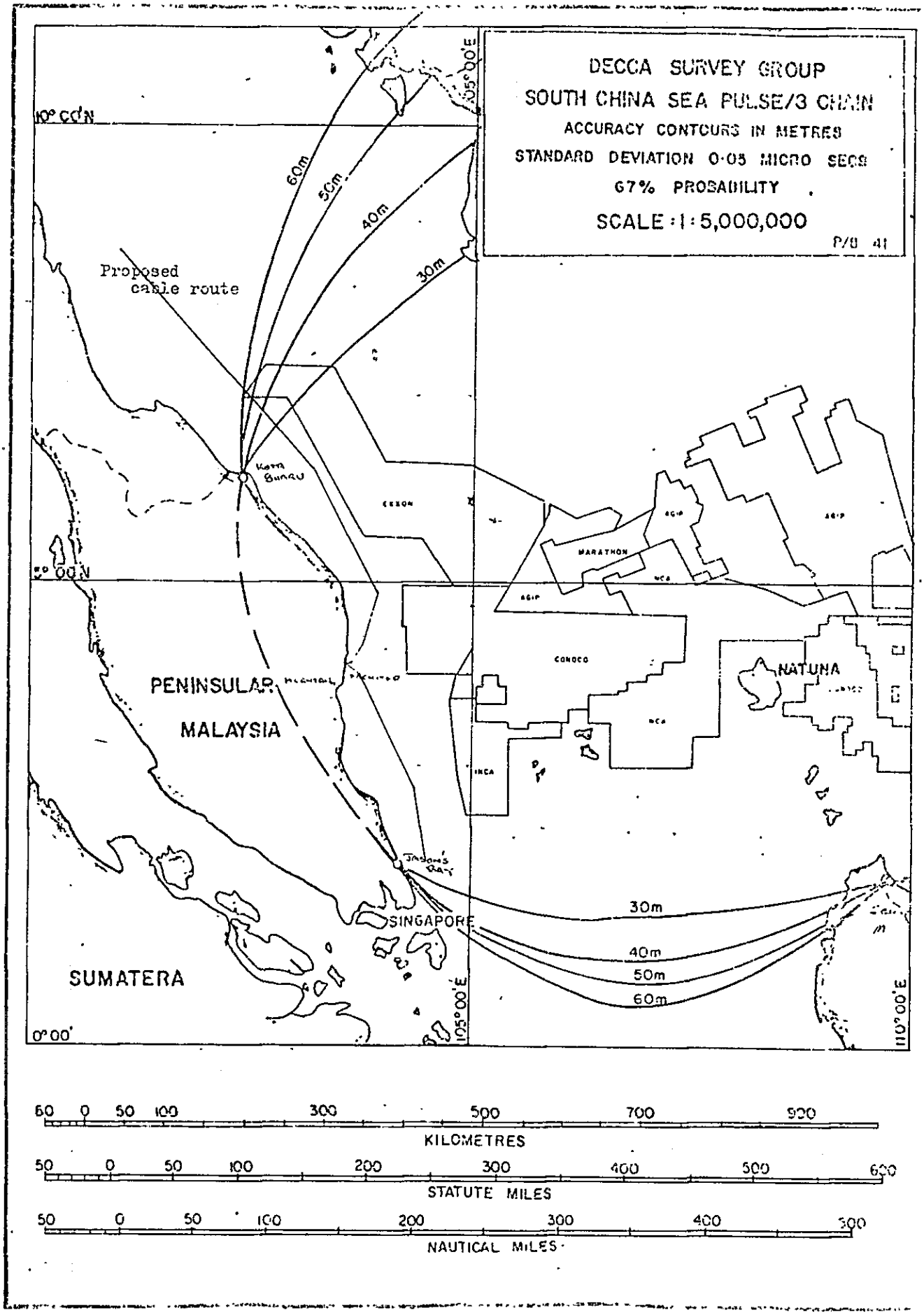
1st day	-	Outfitting of survey ship.
2nd to 4th	-	Going-run survey from Katong to Cherating (Sounding, subbottom profiling and side scan).
5th to 8th	-	Shore survey at Cherating (Sounding, subbottom profiling, side scan, Bottom sampling and Temperature observation - under position control by the Cherating shore).
9th to 15th	-	Going-run survey from Cherating to Petchaburi.
16th to 18th	-	Shore and land survey at Petchaburi.
19th to 25th	-	Returning-run survey from Petchaburi to Cherating. (Sounding, Bottom-sampling, Temperature observation and Bottom photographing)
26th to 29th	-	Returning-run survey from Cherating to Katong
30th to 31st	-	Shore survey at Katong.

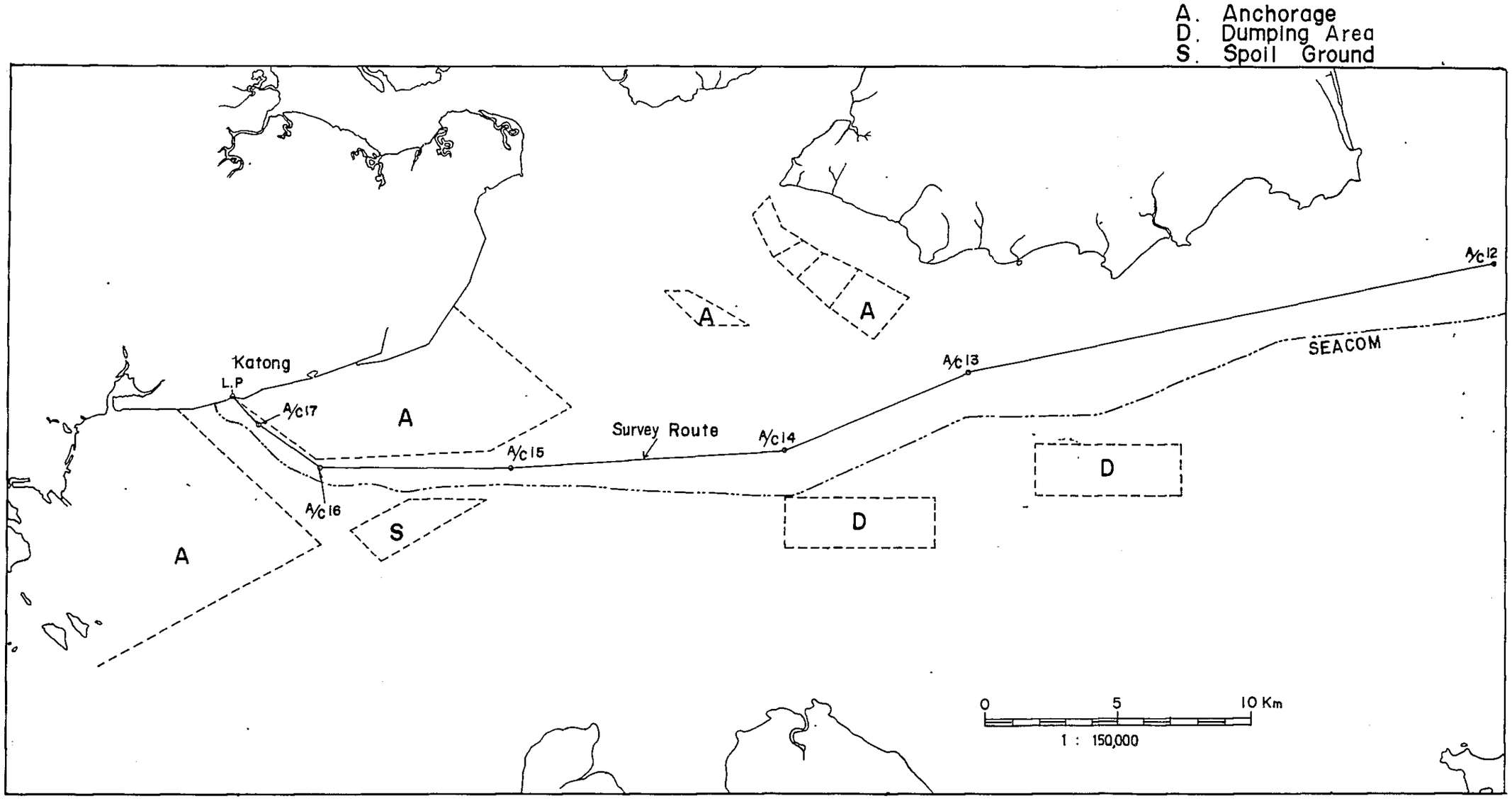


Appendix 4(a) PROPOSED CABLE ROUTE AND THE GASS PIPELINE IN THE GULF OF THAILAND

Appendix 4 (b)

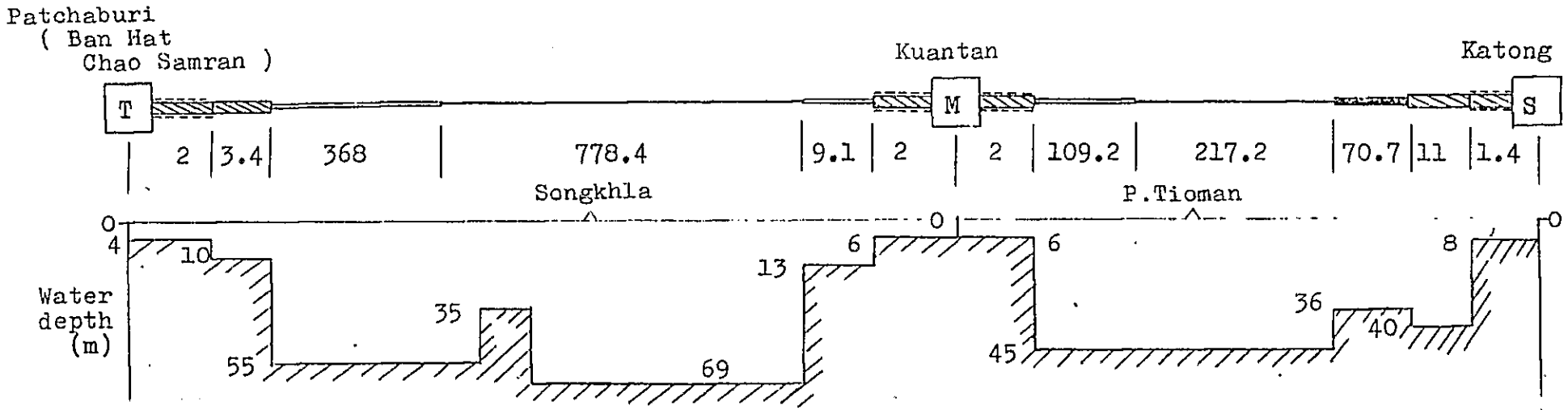
The proposed cable route and petroleum exploration blocks in off Trengganu





Appendix 4(C) ANCHORAGE, EXISTING CABLES ETC IN STRAIT OF SINGAPORE

Appendix 5 An Example of Cable Types



Type of cables \ Cable length (km)	T - M	M - S	T - M - S
Double armored (8/6mm) (Screened)	4	3.4	7.4
Double armored (8/6mm)	3.4	11	14.4
Single armored (8mm)	-	70.7	70.7
Single armored (5mm) (Composite inner cond.)	377.1	109.2	486.3
Armorless	778.4	217.2	995.6
Total	1,162.9	411.5	1,574.4

1) No land cable is included
2) Average slack: 1%
3) Route length: T-M 1,151.4 km
M-S 407.4 km

Appendix 6 List of marine charts used in the route survey

The Japanese Chart

No.623 (1 / 150,000)
624 (")
740 (1 / 307,000)
741 (1 / 566,900)
745 (1 / 500,000)
748 (1 / 50,000)
749 (1 / 75,000)
750A(1 / 50,000)

The US Chart

No.93010 (1 / 1,083,933)
93160 (1 / 242,900)
93220 (1 / 240,000)
93240 (1 / 240,000)
71024 (1 / 500,000)

The British Chart

No.2556 (1 / 27,500)
3542 (1 / 500,000)
3543 (1 / 500,000)
3839 (1 / 100,000)

Appendix 7 A typical example of cable route marker

A pair of cable route marker is designed depending on the applicable distance. An expected visible distance must be decided first, then the visible line connecting the maximum distant point on the sea with the top of sign board of front marker and the bottom of rear marker must be on a straight line. Respective height and distance between those two markers will be determined on the straight line depending upon topography of land and other restrictions. An idea for locating the route marker, an example of the basic design and an example of the configuration and size are shown in Figurel, 2 and 3 respectively.

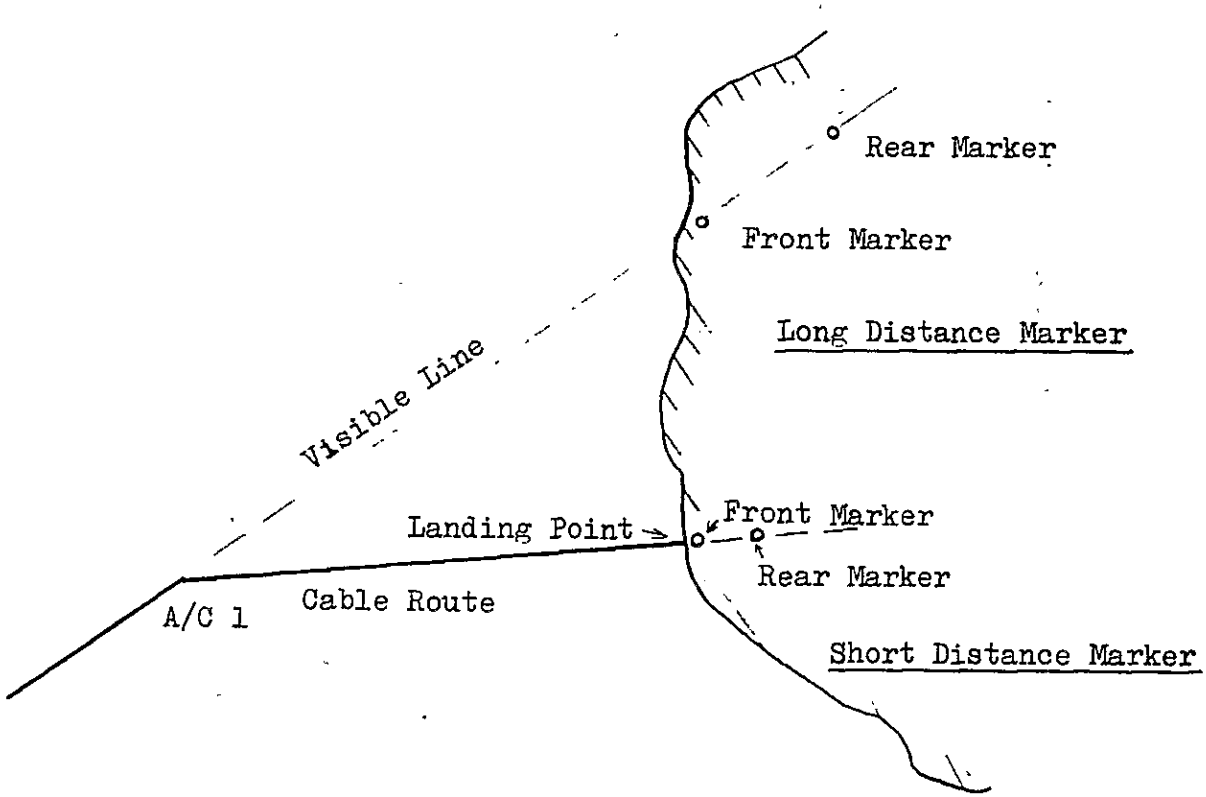


Fig. 1

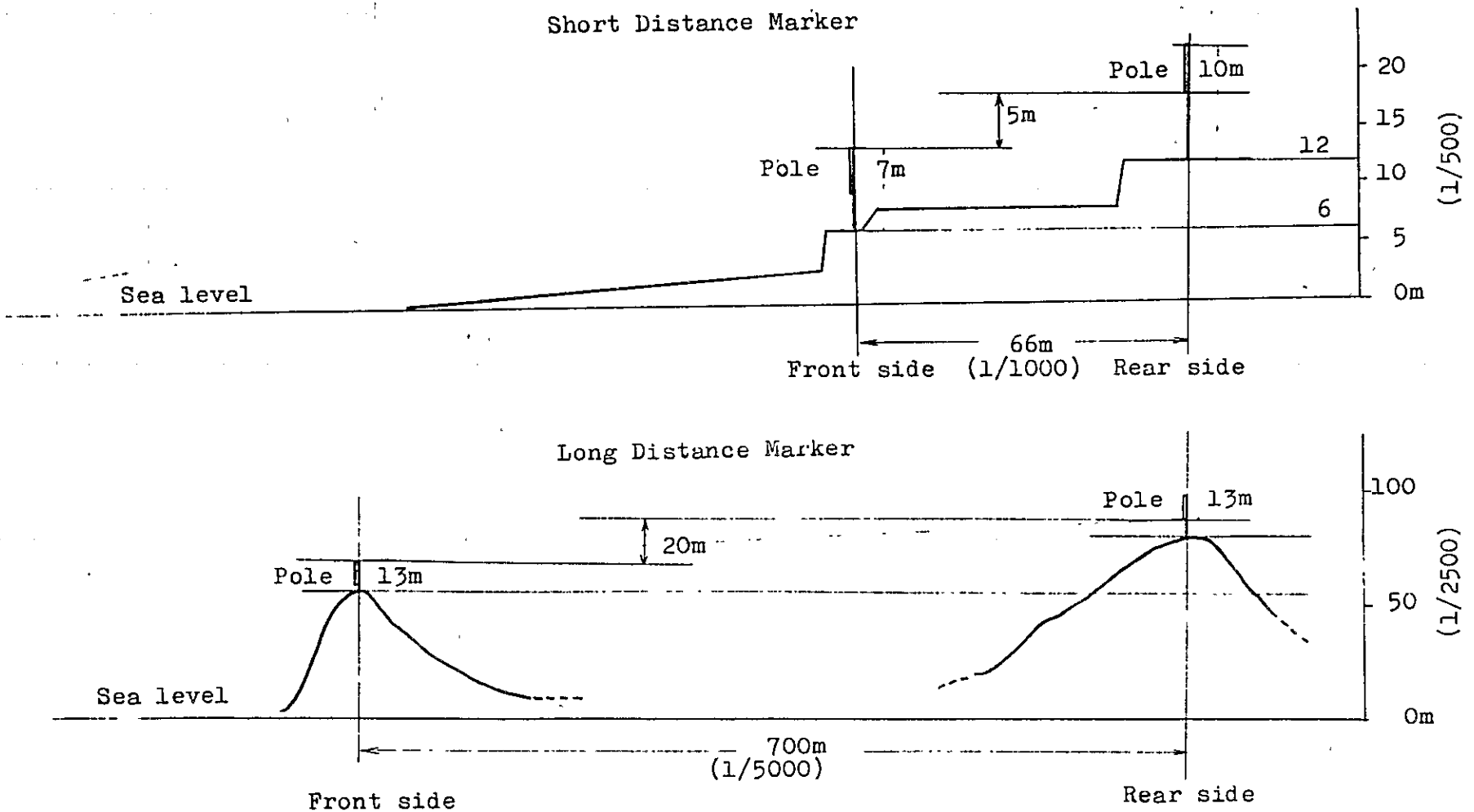
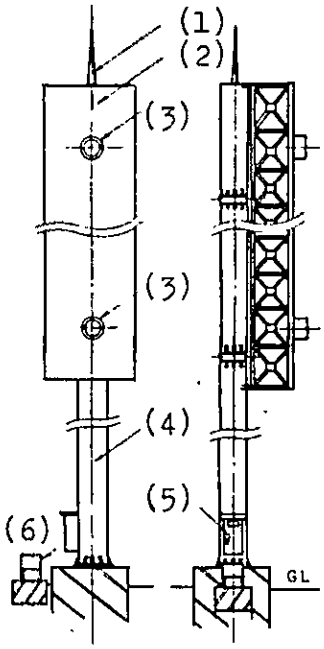

Short Distance Marker
Pole 10m
5m
Pole 7m
12
6
20
15
10
5
0m
(1/500)
Sea level
66m
Front side (1/1000) Rear side
Long Distance Marker
Pole 13m
20m
Pole 13m
100
50
0m
(1/2500)
Sea level
700m
(1/5000)
Front side
Rear side

Fig. 2



Front View Side View

Note;

1) Visible distance at daytime and night time in fine weather, more than 7 km for short distance, more than 20 km and 30 km at daytime and nighttime respectively for long distance.
2) Color of projectors
   Upper projectors are red for both short and long distance, lower one are blue and yellow respectively for short and long distance.

(1) Lightning rod

(2) Sign board (unit in meter)

1.0W X 4.0H for short distance
2.0W X 8.0H for long distance

(3) Projector (incandescent lamp)

300w X 2 for short distance
500w X 2 for long distance

(4) Pole

1.0H(front) and 7H(rear) for short distance
13H both front and rear for long distance

(5) Switch box or control board

(6) Transformer (if necessary)

Fig. 3

Appendix 8 Minimum distance of separation between cables

Minimum distance of separation between cables is required mostly for the purpose of maintanance (Cable repair work). Generally, it is necessary keeping the distance more than 5 times of the water depth for those cables in deep sea portion.

It is usually difficult to take enough distance of separeation, however intend to, between shore-end-cables which are laid in radical manner from a common landing station, and the distance of separation varies with distance from shore. So it can not be specified the minimum distance of separation between those cables. It should be kept as far as possible taking the repair into consideration for the purpose.

Appendix 9 Applicable water depth and burying depth by "Water Jetting method"

Water jetting method functions to bury cable system up to 5 meters depth bellow sea-bed surface by guiding cable and repeater into the ditch dug out by means of pressured water jet from the nozzles which are provided on the digging tool of the burying machine. A required jetting pressure will be decided depend on nature of sea bottom, 7-10 kg/cm^2 are common and it is said that 10 kg/cm^2 is enough for clay of sea-bed which is the most difficult to dig out.

Advantages of this method are that the digging tool can be prolonged and increased the number of nozzle lengthwise, so increasing depth of burying can be achieved and that can be performed either at the same time with cable laying and after cable laying.

The jetting method is effective to protect cable on such hazardous sea-bed where ship anchoring is anticipated as harbor, around sea route and so on. However, that the applicable water depth is limited up to around 50 meters on account of necessity of divers in auxiliary work and that slow burial speed of less than 1 nm per day (8 hours) are also disadvantages.

Appendix 10 Repair technique for buried cable

The cable buried in sufficient depth is far safer from trawling activities compared with unburied cable, it is almost free from artificial damage except heavy anchors which penetrate sea-bed beyond the cable burial depth. However, it is necessary to provide "Repair technique" for buried cable fault which is seldom anticipated.

Repair technique for buried cable must be capable up to the maximum water depth of the cable burying technique. The development of repair method for any buried cable is urgently requested.

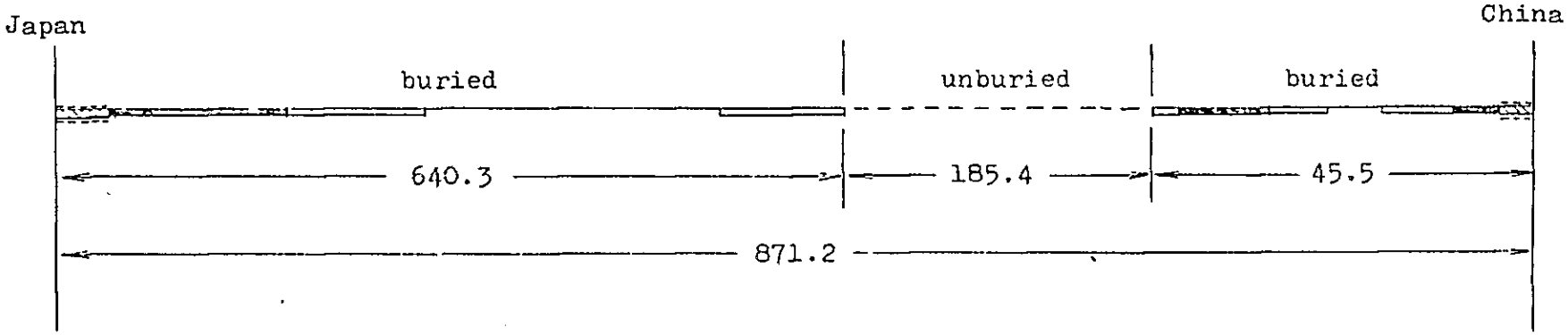
One of the repair method; so called "SCARAB System" is under developped at AT&T in the USA, which consist of a control equipment and a vehicle, the vehicle can be remote controlled by the control equipment on board. The vehicle can reach down to 1800 meters of sea-bed, it performs searching, digging, cutting the cable and fastenning the cable with lifting rope from the vessel.

Development of another method, simple and secure technique is beeing urgently proceeded at KDD and NTT in Japan. It is applicable down to 200 meters of water depth corresponding the maximum depth of cable burying. The KDD's method employs the multi-blade anchor equipped with magnetic or mechanical sensor for catching the cable. The cable caught is to be lifted up on board, extra cable (and repeater if necessary) is to be laid after repair and reburied.

In case sea bottom is hard, it may be difficult to lift up the cable on board unless the cable is cut at sea bed, if it is harder, suction pump may be necessary in addition for lifting the cable. In case of those situation, remote controlled cable-cutter and cable-grab must be provided.

The repair for buried cable in a range of around 50 meters water depth is to be achieved by the method mentioned above, and it is easy because of employing diver work. The cable cutting, cable holding for lifting can be done by divers if necessary, and reburying the cable is also available by water-jetting method.

Appendix 11. Various types of cable used in buried cable systems in Table 3.6.2 of the Final Report in page 165.



	double armored (6/8mm) cable	5.1 km
	single armored (6mm) cable	97.3 km
	single armored (4.5mm) cable (Composite Inner Cond.)	230.2 km
	light weight cable	353.2 km
	total	685.8 km

Japan - China Submarine Cable

Appendix 12 The relation with the current speed and the declination of the moon

Depending on the Newton's equilibrium theory of tide, the equilibrium height of lunar tide ($\bar{\eta}$) is shown as following;

$$\bar{\eta} = \frac{3}{2}\frac{M}{E}\left(\frac{R}{D}\right)^3 \cdot R\left(\cos\vartheta - \frac{1}{3}\right) \text{---------- (1)}$$

M : Mass of the moon

E : Mass of the earth

: Geocentric zenith distance

R : Radius of the earth

D : Distance from the center of the earth to the center of the real moon

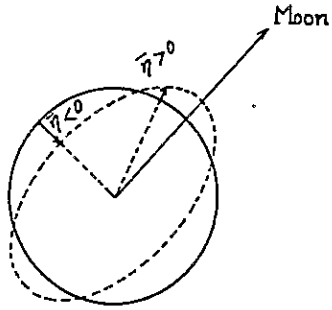


Fig.1 Equilibrium Height of Lunar Tide

The zenith distance ϑ in the formula (1) changes due to the terrestrial latitude of the observer and the moon position on the lunar orbit.

Let 0 be the center of the earth in Fig. 2. P and P', the north-pole and the south-pole in the celestrial sphere; EAE', the equator of the celestrial sphere ; M, the moon and φ, the terrestrial latitude; δ, the declination of the moon; h, the hour angle.

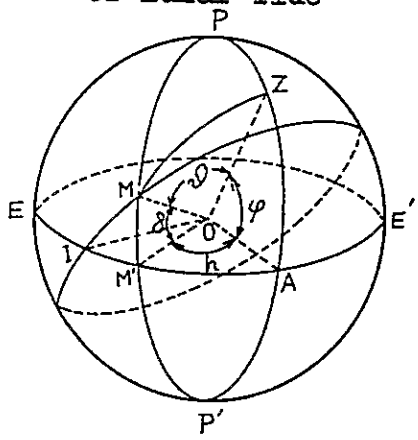


Fig.2 The Celestrial Sphere

In the spherical triangle MZP of Fig. 2, we know from the cosine formula of spherical trigonometry that

$$\cos\vartheta = \sin\varphi\cdot\sin\delta + \cos\varphi\cdot\cos\delta\cdot\cos h \text{ ------- (2)}$$

After the substitution of (2) into (1), we obtain

$$= \frac{3}{4}\frac{M}{E}\left(\frac{R}{D}\right)^3 R\left\{\cos^2\varphi\cdot\cos^2\delta\cdot\cos 2h + \sin 2\varphi\cdot\cos 2\delta\cdot\cos h + 3\left(\frac{1}{3} - \sin^2\varphi\right)\left(\frac{1}{3} - \sin^2\delta\right)\right\} \text{---------- (3)}$$

This formula (3) shows the tide height caused by the moon's attraction at some place on the earth. The terrestrial latitude of the observer Z is constant. The declination of the moon changes with the time, but it is considered as the constant in a day. The hour angle h varies about 360° in a day, so cos 2h is the constituent with periods approximating a half day.

The first term in (3), containing cos 2h, includes the semidiurnal constituents with periods approximating a half lunar day. The second term, depending on cos h, determines the diurnal constituents with periods approximating that of lunar day (24h-50m), and the third term is independent of h but is subject to variations in declination and distance to the moon, both of which vary mainly in the course of month. The long-period constituents, therefore, generally have periods of a half month or longer.

We know the diurnal tide in Singapore strait. So the amplitude of the diurnal tide is given from the second term with cos h in (3) as following;

$$= H \sin \cdot \cos 2 \qquad \text{----------} \quad (4)$$

The amplitude of the diurnal tide is changed remarkably due to the variation of the declination of the moon. As the amplitude of the diurnal tide becomes bigger, the movements of the sea water increases. Consequently, the current speed becomes faster.

(Reference)

Dronkers, J.J., 1964: Tidal computations. North-Holland Publishing Co., Amsterdam

99°

30'

100°

13° 30'

13° 00'

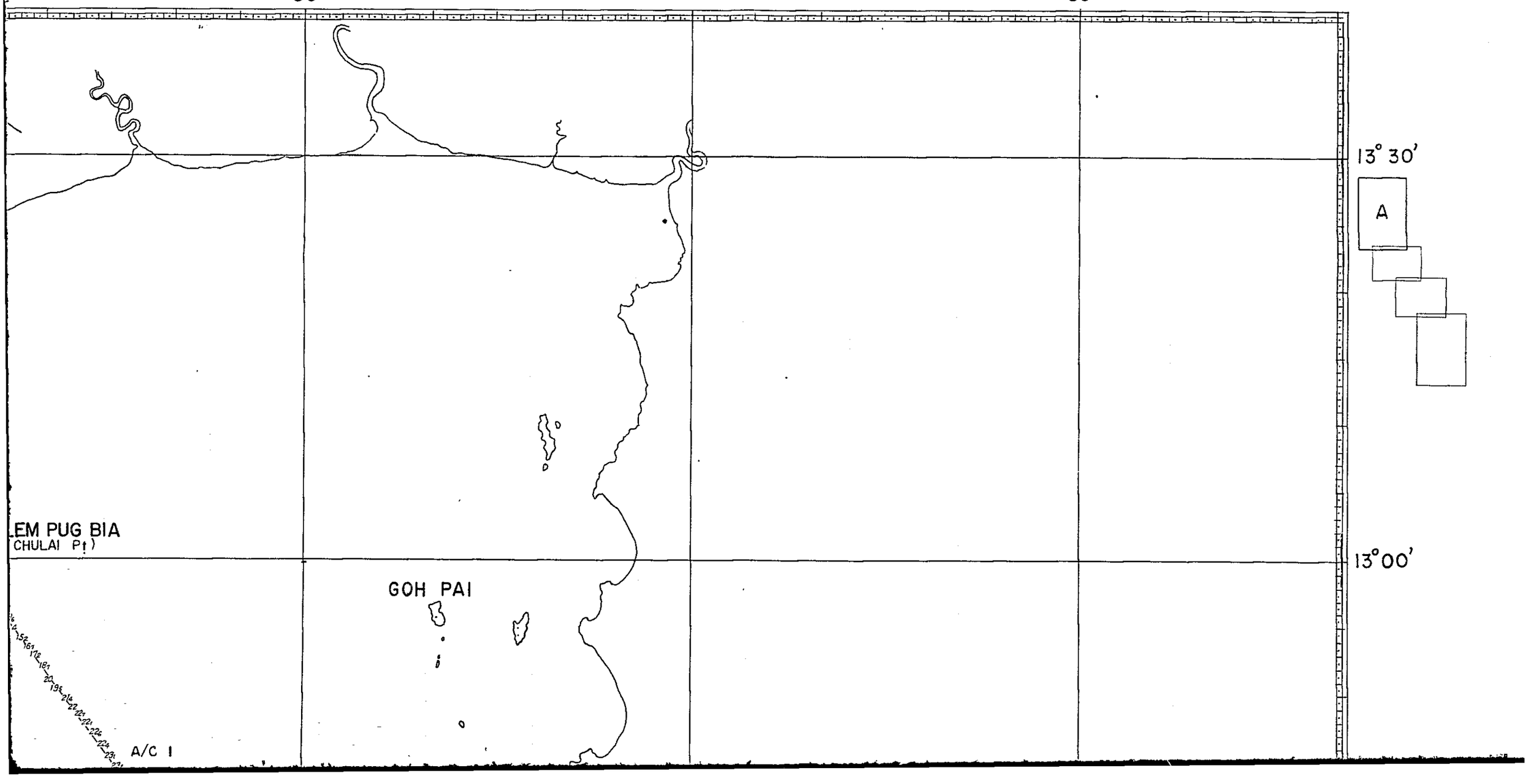
PECHABURI

LEM PUG BIA
(CHULAI Pt)

BAN HAT CHAO SAMRAN

Fig. 3.5.1(A) SOUNDING CHART

1 : 500 000 (at Lat. 7°00'N)



13° 00'

12° 30'

12° 00'

PECHABURI

LEM PUG BIA
(CHULAI Pt)

BAN HAT CHAO SAMRAN

A/C 1

SUI Pt

PRACHUAP

KLEM PUG BIA
(CHULAI Pt)

GOH PAI

GOH KRAM

A/C 1

Pt

13°00'

12°30'

12°00'

100 k.m

12° 00'

11° 30'

11° 00'

PRACHUAB
KIRIKHAN

LEM MAE-RAMPÜN

LEM. YAI
(CHONG P'ra)

100 km 50 0 km 10

12°00' 11°30' 11°00'

11° 00'

10° 30'

10° 00'

LEM. YAI
(CHONG P'ra)

CHUMPORN

GOH TAU

KO PHA-NGAN

km 10

11° 00'

10° 30'

10° 00'

GOH TAU

KO PHA-NGAN

KO SAMUI

AO BAN DON

10° 00'

9° 30'

99°

30'

100°

10° 00'

9° 30'

A/C 2

30'

101°

30'

30'

100°

30'

101°

25'

RAP

LAEM KHAO KHO KWANG

9° 00'

LAEM TALUMPHUK

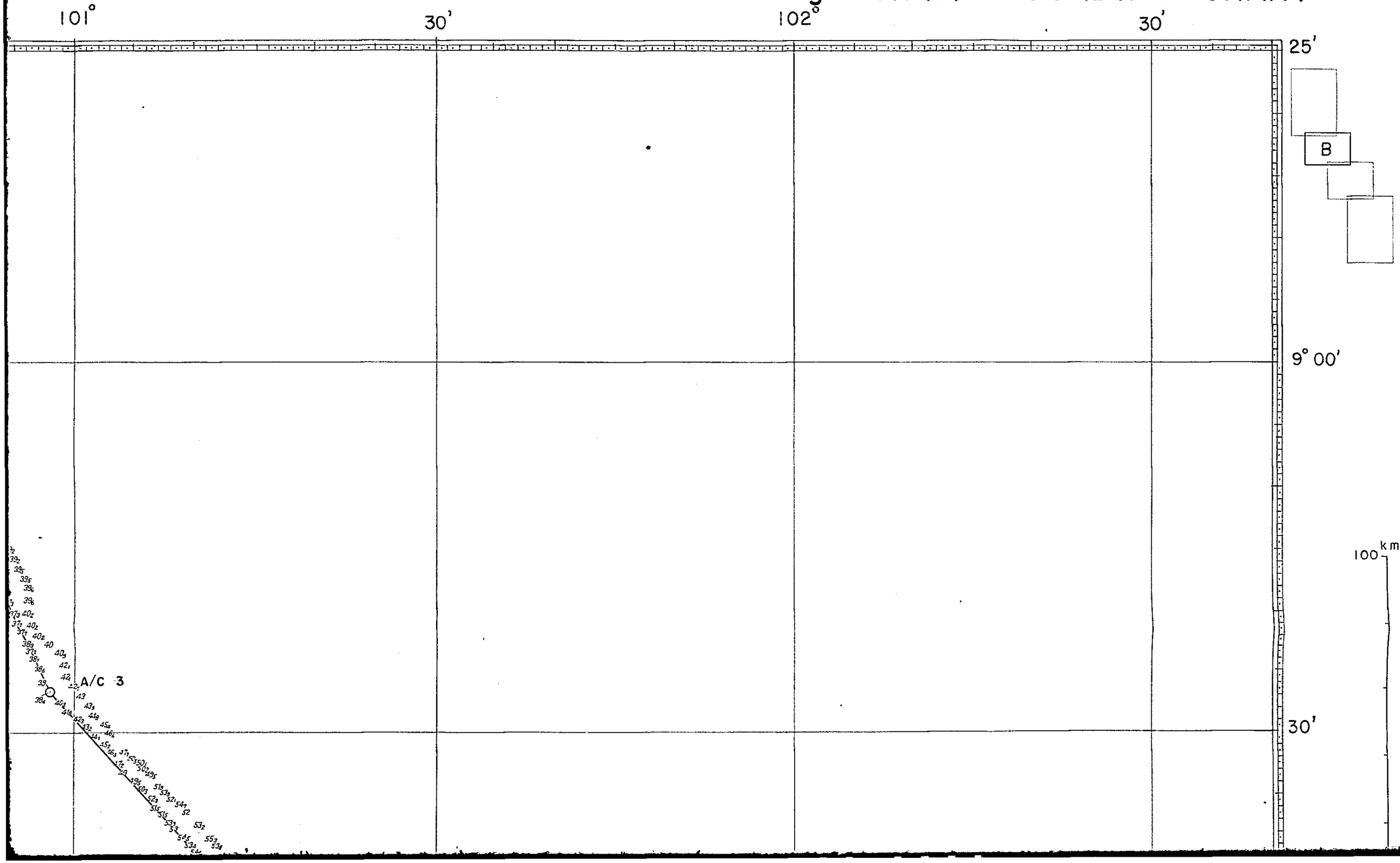
GOH KRAH (51)

A/C 3

30'

1 : 500 000 (at. Lat. 7°00'N)

Fig. 3.5.1 (B) SOUNDING CHART



GOH KRAH
(51)

8° 00'

30'

7° 10'

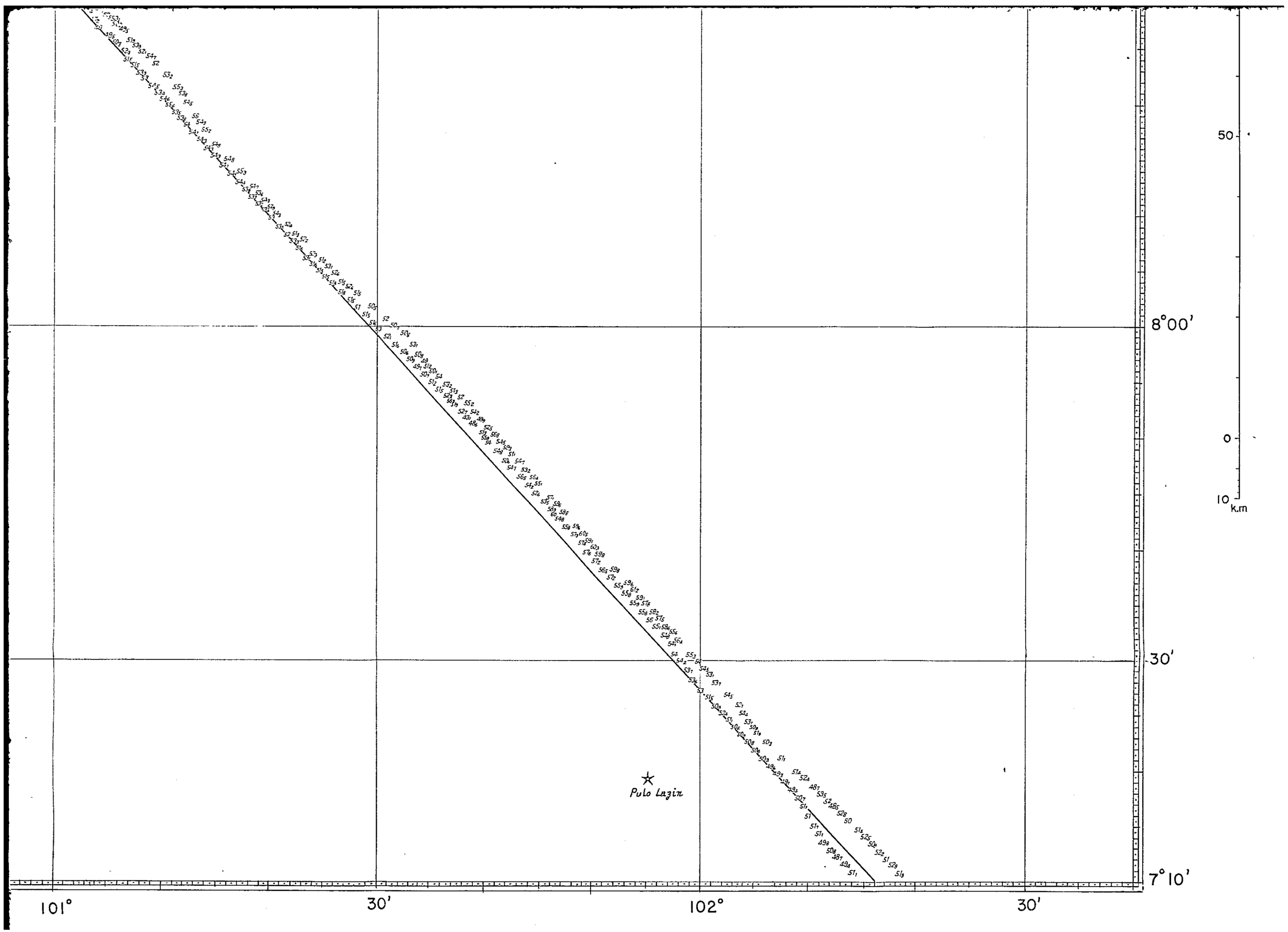
SONGKHLAR
(SINGRA)

30'

100°

30'

101°


50
0
10
k.m
8°00'
30'
7°10'
101°
30'
102°
30'
Pulo Lazin

30'

102°

30'

103°

20'

00'

30'

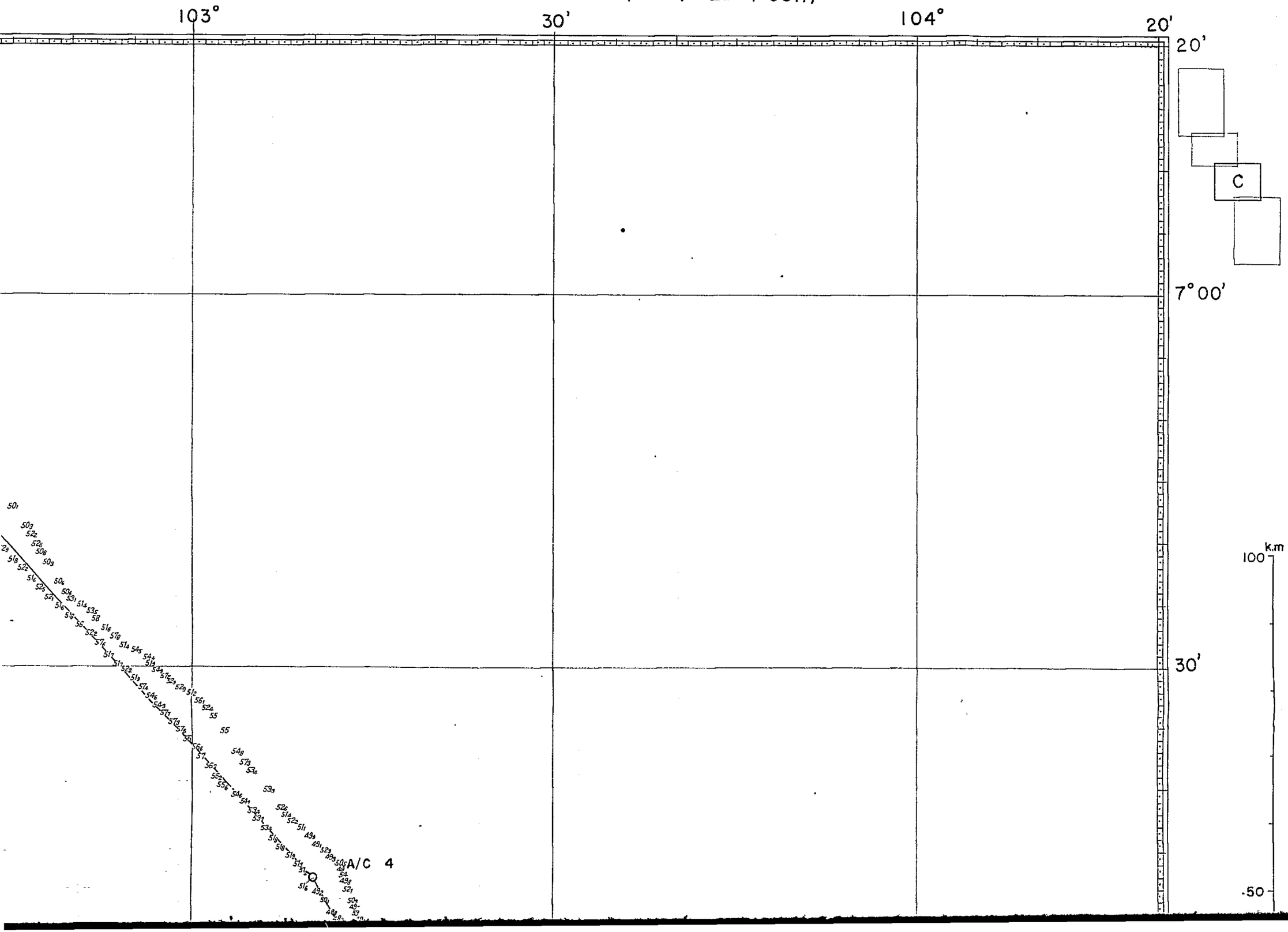
Tg. PATANI

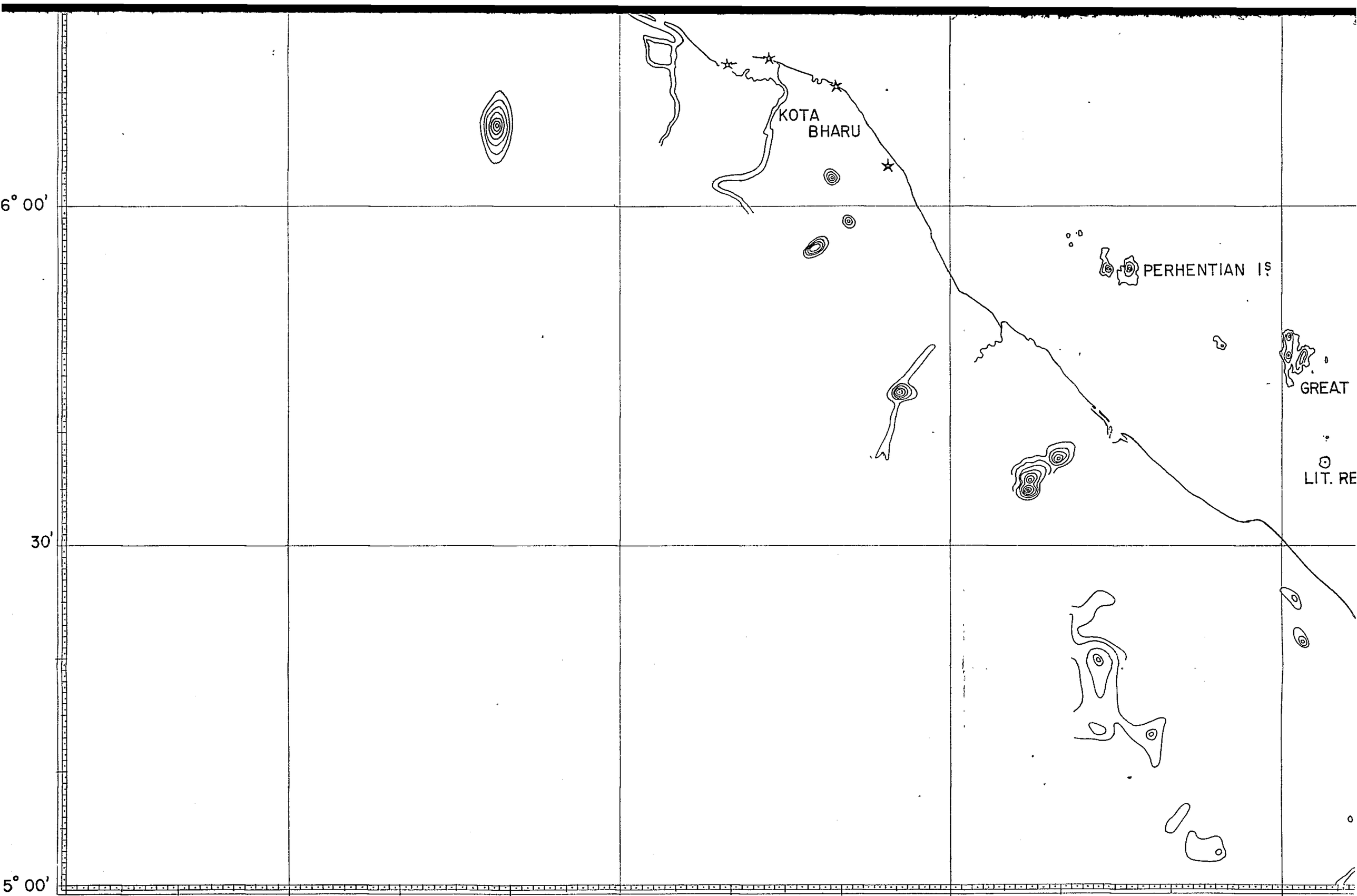
PATANI

HILLY CAPE

Fig. 3.5.1 (C) SOUNDING CHART

1 : 500,000 (at. Lat. 7°00'N)




KOTA
BHARU
PERHENTIAN Is
GREAT
LIT. RE
6° 00'
30'
5° 00'
30'
102°
30'
103°

A/C 4

PERHENTIAN Is

GREAT REDANG I.

LIT. REDANG

P. KAPAS

6° 00'

30'

5° 00'

103°

30'

104°

20'

50

0

10 km

102° 30'

103°

30'

104°

20'

5° 00'

30'

P. KAPAS

P. TENGGOL
(302)

Tg. LABOHAM

A/C 5

Fig. 3.5.1(D) SOUNDING CHART

1 : 500,000
(at Lat. 7°00'N)

104°

30'

105°

30'

20'

5° 00'

30'

D

A/C 5

L

30'

4° 00'

30'

Tg. LABOHAM

Tg. PENUNJOK

CHUKAI

CHERATING

Tg. GELANG

KUANTAN

Kg. PAHANG

PAHANG

A/C 6

A/C 7

A/C 8

30'

A/C 6

4° 00'

A/C 8

30'

100 km

30'

3° 00'

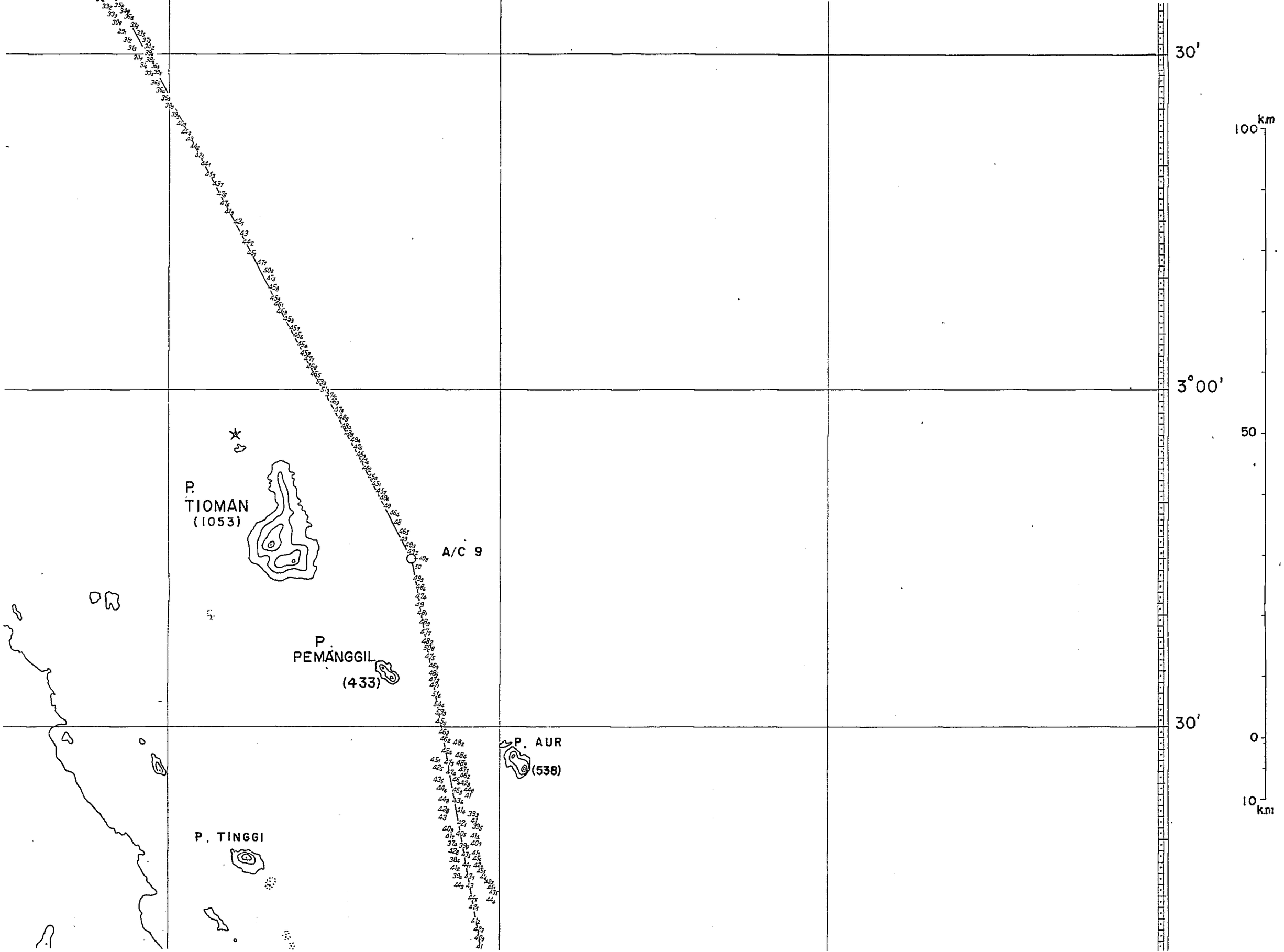
30'

PAHANG

Kuala PAHANG

P.
TIOMAN
(1053)

P. TING


30'
3°00'
30'
100 km
50
0
10 km
P.
TIOMAN
(1053)
A/C 9
P.
PEMANGGIL
(433)
P. AUR
(538)
P. TINGGI

30'

2° 00'

30'

P. TINGG

KATONG

A/C 17

A/C 16

A/C 15

A/C

P. AUR

(538)

P. TINGGI

PU YU

A/C 10

A/C 11

A/C 12

A/C 13

A/C 14

A/C 15

A/C 16

A/C17

KATONG

Tg. BERAKIT

30'

2°00'

30'

0

10 km

30'

1° 00'

40'

KATONG

A/C17

A/C 16

A/C 15

A/C 1

102° 30'

103°

30'

104°

A/C 11

A/C 12

A/C 13

A/C 14

A/C 15

A/C 16

A/C 17

KATONG

Tg. BERAKIT

BINTAN

371

(108)

30'

1°00'

40'

104°

30'

105°

30'