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ON

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IN

[illegible] OF INDONESIA

(PHASE II STUDY)

[illegible]

JAPAN INTERNATIONAL COOPERATION AGENCY

THE FEASIBILITY STUDY REPORT
ON
KALIMANTAN-SULAWESI SUBMARINE CABLE SYSTEM
IN
THE REPUBLIC OF INDONESIA

(PHASE II STUDY)

OCTOBER 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Japanese Government decided to conduct a study on the Kalimantan-Sulawesi Submarine Cable System and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA conducted the phase-I study from August 1987 to January 1988 and sent to Indonesia the Phase-II study team (Ocean Survey) headed by Mr. Fujio KINOSHITA, the Sanyo Hydrographic Survey Co., Ltd. from April 10 to 27, and June 21 to August 31, 1988.

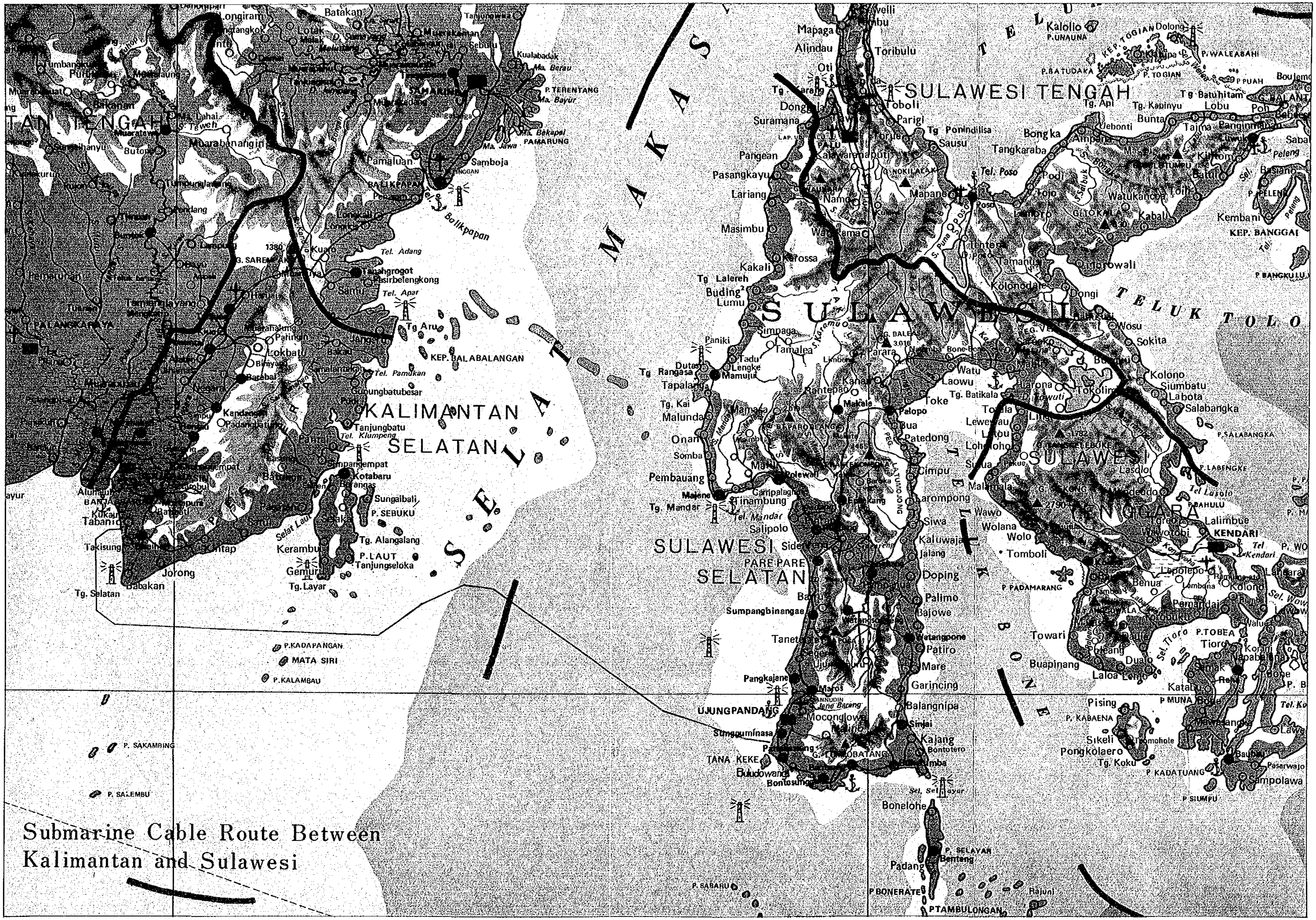
The team exchanged views on the Project with the officials concerned of the Government of Indonesia and conducted an ocean survey. After the team returned to Japan, further studies were made and the present report on the Phase-II study was prepared.

I hope that this report will contribute to the development of the project and to the promotion of friendly relations between two countries.

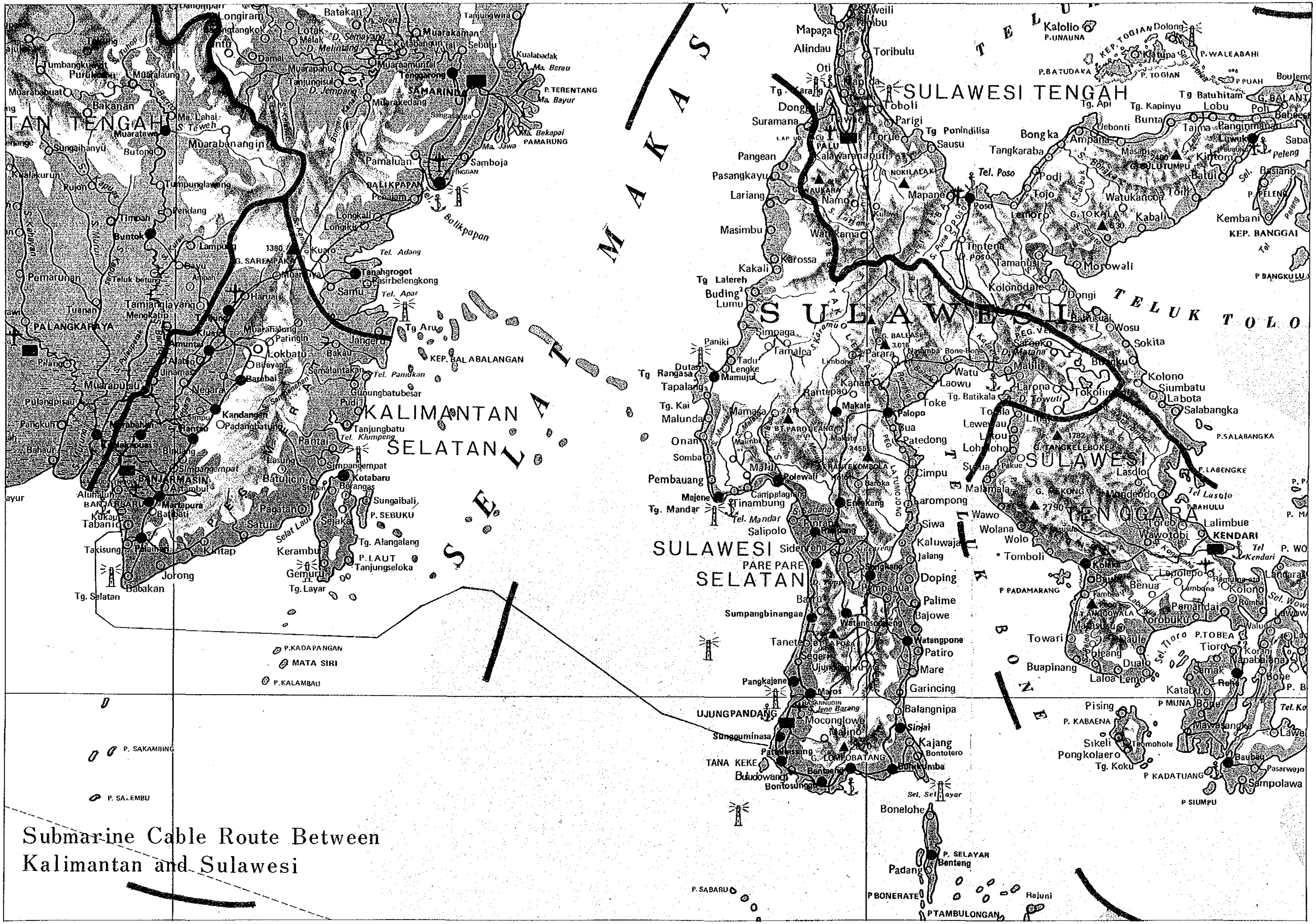
I wish to express my deep appreciation to the officials concerned of the Government of Indonesia for their close cooperation extended to the team.

October 1988

Kensuke YANAGIYA
President
Japan International Cooperation Agency



Submarine Cable Route Between Kalimantan and Sulawesi



Submarine Cable Route Between Kalimantan and Sulawesi

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SUMMARY

SUMMARY

The Phase-I Study of the Kalimantan - Sulawesi Submarine Cable Project, which was requested from the Japanese Government by the Government of the Republic of Indonesia, had been done from August to November 1987 by the Japan International Cooperation Agency (JICA). In this study, the Project was investigated from the following viewpoints.

* Estimation of traffic demand and required channel capacity through the cable
* Analysis of economy and finance
* Selection of submarine cable route
* Basic design of submarine cable and backhaul system
* Preparation of implementation plan

After careful investigation of the above mentioned points, JICA established an entire submarine cable system construction plan between Kalimantan and Sulawesi, and a final report on the Phase-I Study was submitted to the Government of the Republic of Indonesia in June 1988.

Concerning the planned submarine cable route between Takisung (Kalimantan) and Bonto Marannu (Sulawesi) as shown on Fig. S-1, a study of the cable route was made with existing nautical charts, geological and geographical records, and by observation of both cable landing sites.

The Phase-II study of the Kalimantan - Sulawesi Submarine Cable Project was undertaken to confirm the availability of a planned cable route by the Ocean Survey and to survey both landing sites precisely.

The Phase-II Study of the Kalimantan - Sulawesi Submarine Cable Project was done by the JICA Study Team from April to August 1988 with cooperation from the Government of the Republic of Indonesia (POSTEL & PERUMTEL). The study was divided into two periods. The first period was performed from April 10th to 27th, 1988 for submitting and explaining the Inception Report of the Phase-II Study to POSTEL and PERUMTEL. The field survey of both cable landing sites to determine the cable landing points was also carried out during the first period with cooperation of WITEL IX and X. The second period consisted of the Ocean Survey, which was performed from June 28th to July 22nd, 1988 with cooperation from POSTEL, PERUMTEL and the support of the Indonesia Navy.

After acquisition of a security clearance for the shipboard survey work, the Japanese survey ship Wakashio Maru left Moji for Banjarmasin on June 14th and arrived at Banjarmasin on June 27th, 1988. The second period of the Phase-II Study (Ocean Survey) was commenced on June 28th with 16 Study Team members, three PERUMTEL counterparts and three naval officers on board. The ocean survey was carried out in the following sequence: Takisung landing site and inshore survey, going run survey, Bonto Marannu landing site and inshore survey, and return run survey 2 nm south along the planned cable route. The time schedule of the whole survey is shown in Table S-1.

From this ocean survey, the following points became clear.

(1) At the Takisung inshore portion, a rock outcrop was found on the planned cable route about 1,500 m off from the beach.

(2) Between A/C 5 and A/C 6 and, near the A/C 7, abundant coral reefs appeared on the sea bottom.

(3) Both slopes from the continental shelf to the bottom of the Makassar Strait are steep at an angle of 10-13 degrees. And both edges of the shelf were rich coral reef outcrops up and down.

(4) During the Balang cable landing site survey, it became clear to WITEL X and Takara Province personnel that the cable landing site was located at Bonto Marannu (1.6 km south of Balang).

Concerning points (2) and (3) above, supplementary surveys were conducted on the return run to find a better cable route. Upon completion of the supplementary surveys, the planned cable route was changed slightly by adding four new A/C points as shown on Fig. S-1 and the route length is elongated about 4 km. Detailed survey work and results thereof are described in the following chapters. As mentioned above (4), the cable landing site designation at Sulawesi was changed from Balang to Bonto Marannu in this report.

The personnel who participated in the Phase-II Study of the Kalimantan - Sulawesi Submarine Cable Construction Project are as follows:

(A) Indonesia Governmental Agencies

* POSTEL

Mr. Sri Slamet	BC.T.T.	Deputy Director General
Ir. Rollin		Deputy Director General (former)
Ir. Kesmarihati Sugondo		Planning and Programming
Mr. Suhardi	BC.T.T.	Telecommunication Planning
Mr. Soedarpo	BC.T.T.	Telecommunication Directorate
Mr. Bambang Setiawan		Telecommunication Directorate

* PERUMTEL

Mr. Saleh Gunawan		SUBDITBINPROPEMTEL
Mr. Syonan Sembiring		BINPROTRATEL
Mr. Usman Azyoni		BINPROTRATEL
Mr. Sugeng Winarto		BINPROTRATEL
Mr. Maman		BINPROTRATEL
Mr. Kisworo	BC.T.T.	WITEL IX
Mr. Sugiono		WITEL IX
Ir. Effendi Sutanto		WITEL X
Mr. Soeharto	BC.T.T.	WITEL X
Mr. Tatang Wigena	BC.T.T.	WITEL X
Mr. Joko Ukmono		WITEL X

* NAVY

Mr. Djoko Soetopo Mayor Laut	PUSSURTA ABRI
Mr. Suyadi Mayor Laut	DISHYDROS
Mr. Nugroho Mudjianto Letda Laut	DISHYDROS

(B) Study Team

Name	Responsibility	Agency
FUJIO KINOSHITA	Leader, Cable Route Analysis	Sanyo Hydrographic Survey Co. (SHS)
YASUO NISHIYAMA	Bottom Topography Analysis	ditto
SHIGEAKI KUBO	Bottom Sediment and Geological Structure Analysis	ditto
NOBUYOSHI TOKUNAGA	Ship Position Analysis	ditto
TAKEJI OHTSUKA	Oceanographic Analysis and Sea bottom profiling planning	ditto
KUNITOSHI HASHIMOTO	Magnetic Prospecting Analysis	ditto
HACHIRO FURUSAWA	Positioning and Current Observation	ditto
YASUYUKI YOSHIHARA	Sea Bottom Profiling	ditto
MITSUHIRO ABE	Sea Bottom Profiling and Water Thermometry and Current	ditto
YASUNORI WATANABE	Sea Bottom Profiling and Magnetic Prospecting	ditto
KUNIAKI AKIYAMA	Sea Bottom Profiling and Sampling	ditto
AKIRA OHTANI	Sea Bottom Scanning and Photographing	ditto
NOBORU NITTA	Magnetic Prospecting and Control Point Survey	ditto
MORIO KOYAMA	Mangetic Prospecting and Control Point Survey	ditto
HITOSHI IESATO	Sea Bottom Scanning, Photographing and Water Thermometry	ditto

(C) Advisory Committee

Name	Responsibility	Agency
NORIO SEKI	Chairman	MPT
HARUO AZAMI	Chairman (former)	MPT
AKIRA NAGAI	Member	KDD
SHIGEO YAMAMOTO	Member	KDD
TOSHIAKI KONTA	Member	MPT
KINICHI UMEYA	Member	JICA
TOHRU TAGUCHI	Member	(JICA Jakarta)

Table S-1 Ocean Survey Time Schedule

June 14th 1988	:	Survey vessel (Wakashio-Maru) left Japan
21st	:	Survey Team of three persons arrived at Jakarta
22nd-26th	:	Courtesy Call (Japan Embassy, JICA office, POSTEL) * Meeting & Discussion (POSTEL, PERUMTEL, NAVY) * Preparation of ocean survey * Survey Team of 13 persons arrived at Jakarta
27th	:	Survey vessel arrived at Banjarmasin * Study Team of 16 persons left Jakarta and arrived at Banjarmasin
28th	:	Survey Team, counterparts and Naval officers boarded survey vessel which left Banjarmasin
June 29th-July 1st	:	Takisung landing site, inshore and land survey
July 2nd-6th	:	Going run survey to Bonto Marannu (Sulawesi)
7th-11th	:	Bonto Marannu landing site, inshore and land survey
12th-21st	:	Return run survey to Takisung (Kalimantan)
22nd	:	Survey vessel arrived at Banjarmasin
23rd	:	Study Team of six persons, counterparts and Naval officers disembarked from survey vessel * Study Team of 16 persons left Banjarmasin for Jakarta
24th	:	Survey vessel left Banjarmasin
25th	:	Study Team of 10 persons left Jakarta

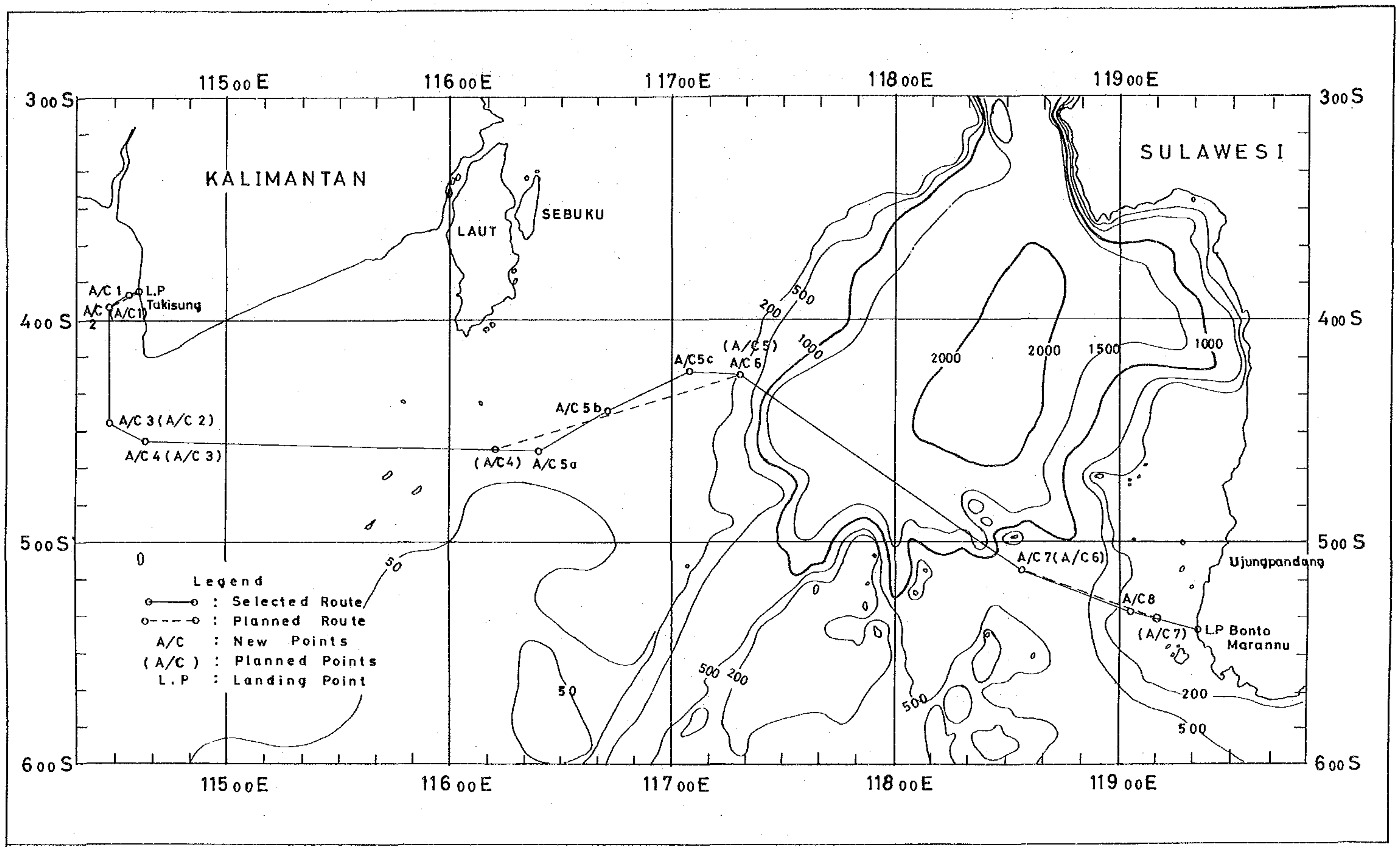

Fig. S-1 Cable Route Between Kalimantan and Sulawesi

CHAPTER 1 DESK TOP STUDY

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1.1 General

Before starting the ocean survey, the study Team has made desk-top study in Japan around the cable ground where the Kalimantan - Sulawesi Submarine Cable will be laid, by using various data and informations available not only in Japan but also in Indonesia. And also this chapter contains data obtained through the ocean survey.

The major data and informations utilized throughout this chapter are as follows.

* Ben-Avraham, Zvi, and Emery, K.O., 1973.
  Structural frame work of Sunda Shelf.
* Emery, K.O. et al., 1972.
  Geological structure and some water characteristics of the Jawa Sea and adjacent continental shelf.
* Katili, J.A., 1975
  Geological environment of the Indonesia mineral deposits.
* Hydrographic Department of Ministry of Defense, U.K. 1983.
  Indonesia Pilot V.2.
* Petroconsultants, S.A., August 1985, Petroleum Activity Indonesia.
* Hokuryukan Co. Ltd. November 1987, illustrated fishes of the world in colour.
* Nautical Charts relating to cable route survey area.

1.2 Submarine Topography and Geology Adjacent to Cable Route

With regard to the submarine cable construction project, the planned cable route is set up between Takisung (Kalimantan Selatan) and Bonto Marannu (Sulawesi Selatan) via East Northeast of the Jawa Sea and Makassar Strait.

Nowadays, Kalimantan and Sulawesi are separated into two islands by the Makassar Strait. However, from a geological point of view, Sulawesi was a part of Kalimantan at the Middle Paleogene.

Then at the end of Late Paleogene, Sulawesi was drifted to South-East direction and, the Makassar Strait was born as a Rift Zone. (W. Hamilton 1979).

The submarine topography along the planned cable route can be divided into three portions, they are the ENE portion of Jawa Sea, Makassar Strait and the coastal area of Sulawesi Selatan.

The sea bottom of Jawa Sea is generally flat, but there are so many small islands at ENE portion. And between the eastern edge of it and the down slope to Makassar Strait, there are many coral reefs of various sizes on the seabed. The seabed of this portion is covered by the stratum of Neogene period and Quaternary with the thickness of 2000-4000 meters, and the basement rock of Cretaceous Age and Palaeogene period lies beneath the stratum. The stratum of upmost is a sediment layer of Plesitocene Age. And this layer has a complicated geological structure due to the repetitive erosion and deposition by a shift of sea level at Glacial Age. (K.O. Emery et al., 1972).

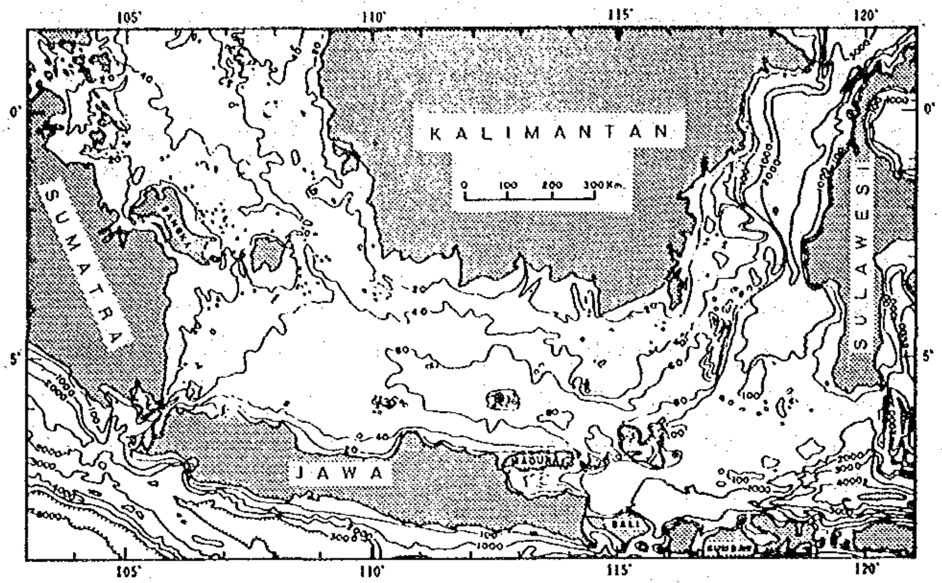
The bottom material of ENE portion of Jawa Sea mainly consists of mud and sandy mud. (K.O. Emery, 1972 -- Refer to Fig. 1-1 and 1-2). But at the offing of Tanjung Selatan, there are sandy bottom material spreaded widely, and also, rock outcrops at the coastal area of Takisung and Makassar Strait.

At the crossing portion of the planned cable route with Makassar Strait, the width and the deepest depth is nearly 230 km and 1900 m respectively. The both up slopes from the bottom of Makassar Basin to Jawa and Sulawesi Shelf are steep with rock outcrops.

The sediments of Makassar are a coral sand at the shallower part, then mud is contained into coral sand by increasing depth. The deep part of the Strait is covered with mud.

The continental shelf of the west coast of Sulawesi Selatan is wide along the planned cable route in comparison with other area. The width is nearly 40 km and the sea depth is mostly less than 100 m. The sea bottom is almost covered by coral sand and coral reefs appear on the bottom of the self margin. As described hithereto, there are several area which are unsuitable for submarine cable route from the topographical and geological points of view, accordingly a precise ocean survey has to be carried out on such area so as to find out a suitable cable route.

SUBMARINE TOPOGRAPHY



BOTTOM SEDIMENTS

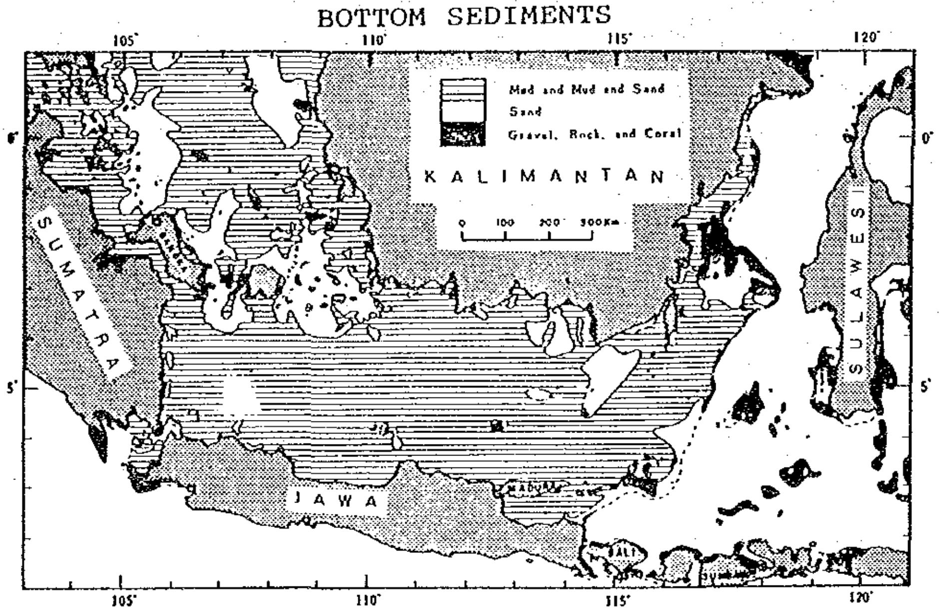
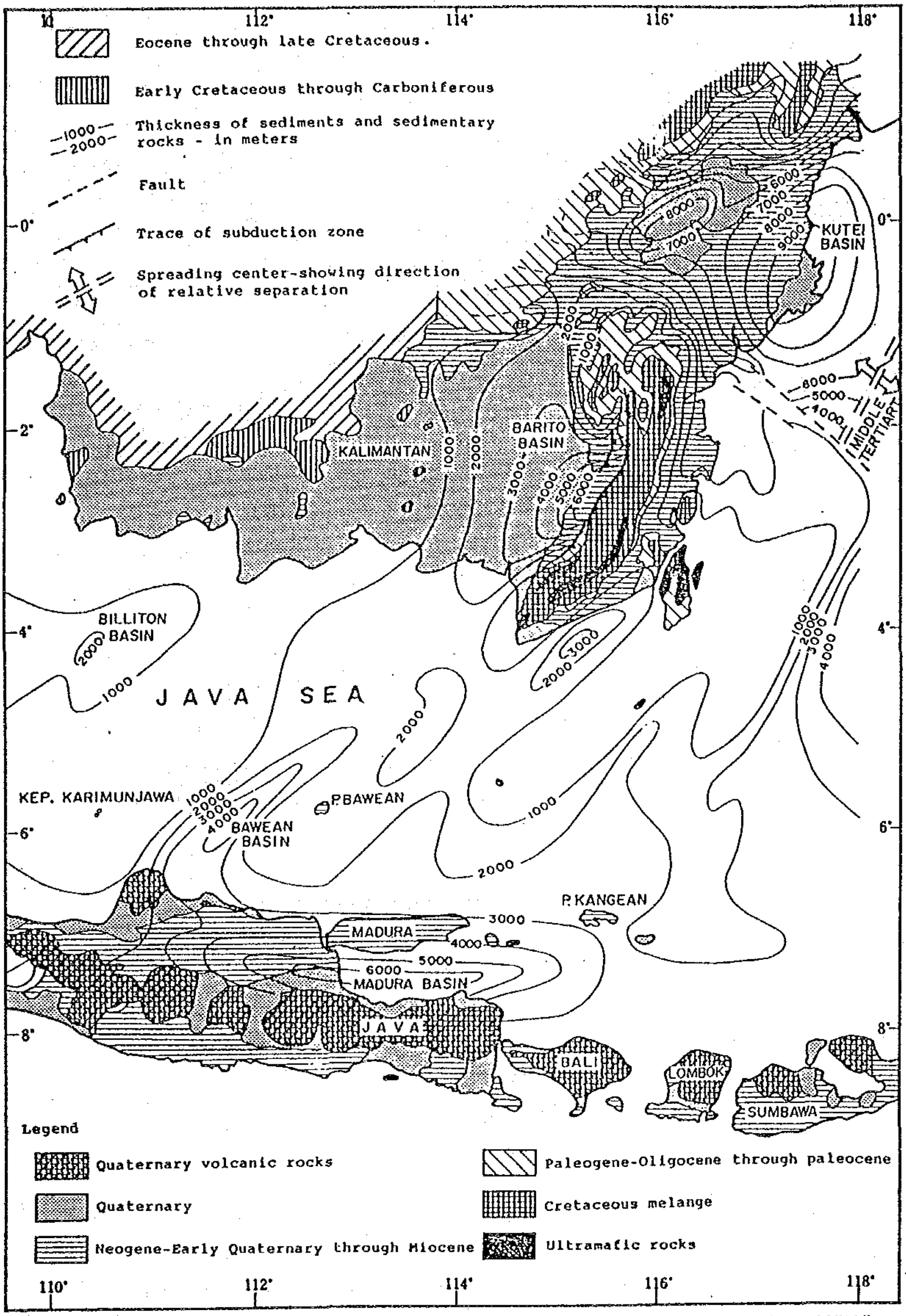


Fig. 1-1 Submarine Topography, Bottom Sediments
(Modified from K.O. Emery et al., 1972)



Simplified "Tectonic Map of Indonesian Region (W. Hamilton,1978)"

Fig. 1-2 Geological Map

1.3 Weather, Currents and Water Temperature

The area adjacent to the cable route has a tropical monsoon climate. Typical type of monsoon climate is wet and dry season. The wet season is in the NW monsoon, and the dry season is in the SE monsoon.

The NW monsoon is from November to March and the SE monsoon from May to September.

In the SE monsoon, the wind mainly blows between E and SE. The wind force is also 2 to 4.

Near the coast, wind is affected by local and irregular variations caused by the topography and local conditions.

The gale accompanied with a squall or a thunderstorm reaches 6 to 7 in terms of wind force, and the wind direction suddenly changes also. Some squall is violent, and it may suddenly develop greater, resulting in temporary hazard to small vessel. There is no record to tropical depressions and cyclones adjacent to the area.

The climate is hot and humid without seasonal variation. In the wet season, the rainfall is three times as much as that of dry season.

The fog is rare, but visibility may fall bad in heavy rain. The monthly mean of air temperature at sea in this area is between 25°C and 29°C thoroughout a year without seasonal variations.

The currents in the Jawa Sea are governed by the monsoon wind (Fig. 1-3). The currents alter their directions twice a year due to the difference of wind direction in the two seasons. The ocean currents in the Jawa Sea, come from the Pacific

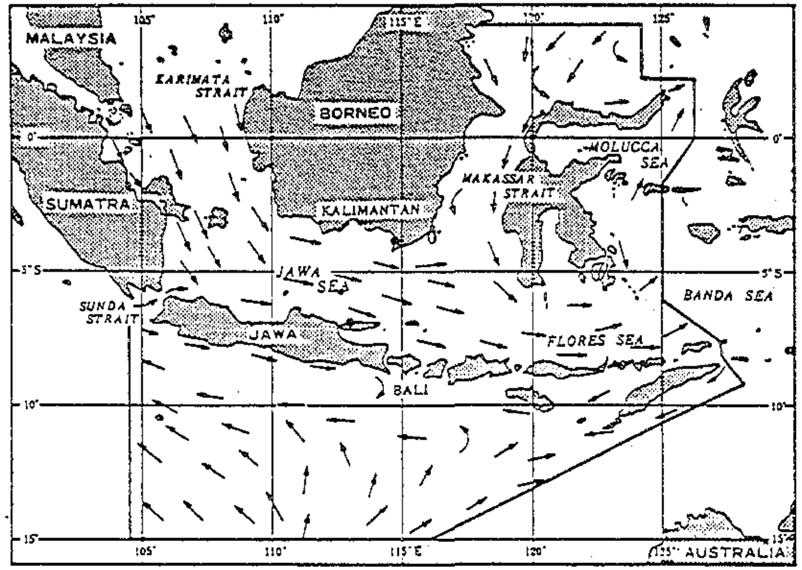
Ocean. In the NW monsoon, the currents come from the Pacific Ocean via the South China Sea and, in the SE monsoon, from the Pacific Ocean via the Flores Sea.

The dominant current directions coincide with tendency of the monsoon. During the NW monsoon, the current directions are set in the direction between E and ESE, during the SE monsoon, these are set in the direction between W and WNW.

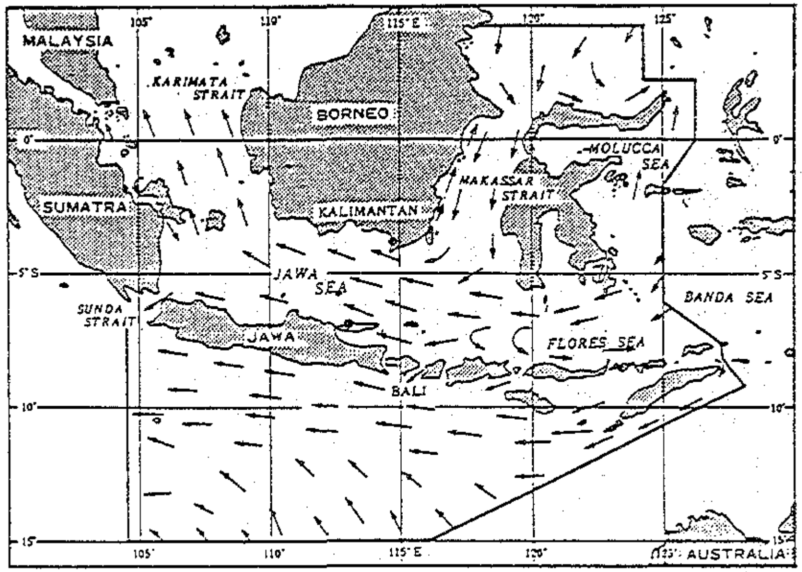
The maximum current velocity rarely exceeds 3 knots at the monsoon transition time. It is generally up to 2 knots. The current velocities are a little stronger in the NW monsoon than in the SE monsoon. The former is on the order of 1.0 to 1.5 knot; the latter is about 0.8 knot. The wind waves and swells are generally not so high, but continuously blowing the monsoon winds make them higher.

The tide throughout the area have a marked diurnal inequality. This tendency appears especially on the coast of Kalimantan. The tidal range in the spring tide is about 2.5 m at Takisung.

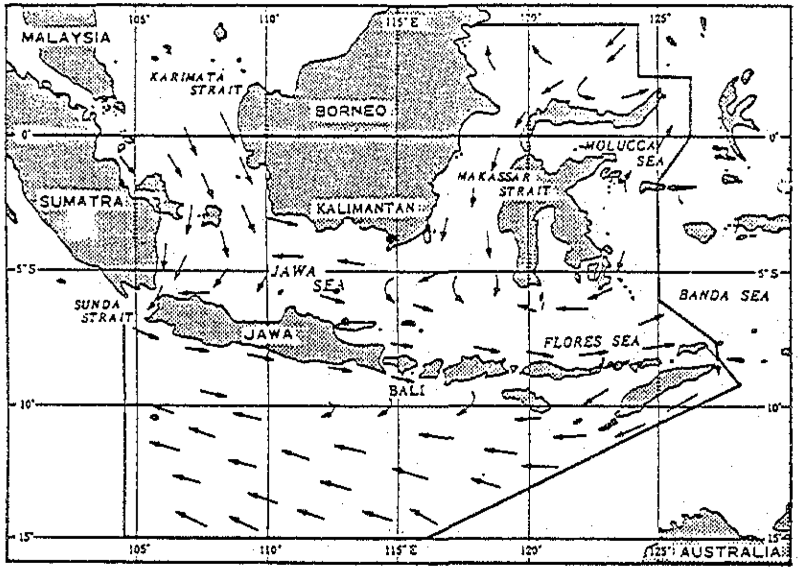
The water temperatures of sea surface vary from 26°C to 29°C. The highest water temperature appears during April and May, and the minimum value appears in September.



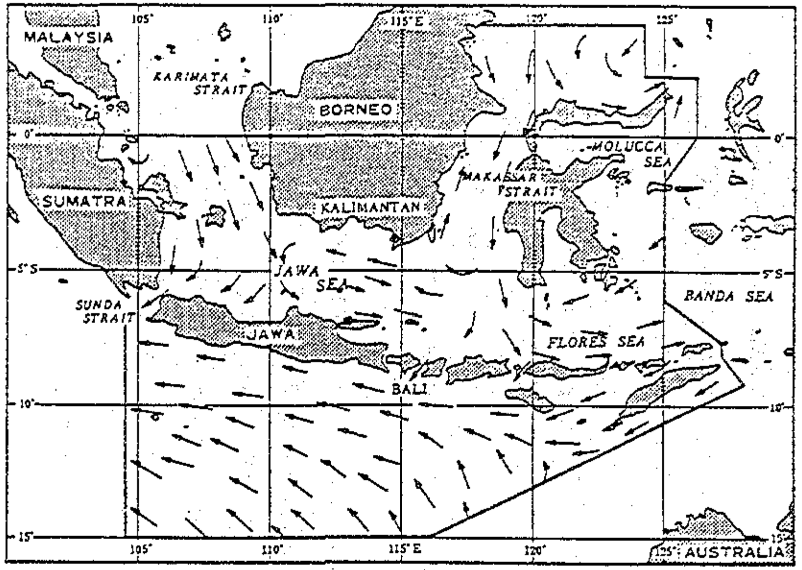
NW Monsoon (February)



SE Monsoon (August)



Monsoon in Transition(April)



Monsoon in Transition(October)

Fig. 1-3 General Surface Currents Circulation in the Jawa Sea (British Pilot Book)

The ocean survey period in July was the mid-season of SE monsoon of the year. Therefore the Study Team has made a detailed study on the weather condition at the Takisung inshore portion, offshore portion and Bonto Marannu inshore portion. This study was based on the record of log book of the Wakashio Maru which recorded the wind direction, wind force (Beaufort Scale), and the weather condition at every 4 hours.

Table 1-1 Takisung Inshore Portion (June 27th - July 1st)

Wind Direction	S	SE	ESE	ENE	NNW	Total
Number of records	1	13	1	1	1	17
Percentage	6	76	6	6	6	100

Wind Force	2	3	4	5	6	Total
Number of records	5	10	0	1	1	17
Percentage	29.4	58.6	0	6	6	100

Weather of Condition	bc	c	r/d	Total	Remarks
Number of records	4	9	4	17	bc: fine but cloudy c: cloudy
Percentage	23.5	53	23.5	100	r: rain d: drizzle

Observing Table 1-1, the following matters can be pointed out.

(a) The wind direction is mostly SE and this shows the typical feature of the SE monsoon season.

(b) The wind force is mostly 2-3 (Beaufort Scale), but it rises 5-6 with probability of 10% and sea condition changes into storm at this time.

(c) The weather condition shows that cloudy sky and rain is 73% of records. The reason of this would be that the moisture carried by the SE wind changes a cloud by meeting of high mountains at the Kalimantan.

It was observed at the Takisung inshore portion by the visual survey, that, the SE wind force increases by 2-3 millibar down of the atmospheric pressure. And this increase of the wind force starts around noon and continue up to sunset, then the wave height becomes 1.5-2 m. Due to this high wave, the inshore survey was sometimes interrupted.

Table 1-2 Bonto Marannu Inshore Portion (7th - 11th July)

Wind Direction	SSE	SE	S	W	N	E	Calm	Total
Number of records	10	5	3	1	1	1	3	24
Percentage	41.6	20.8	12.5	4.2	4.2	4.2	12.5	100%

Wind Force	0	1	2	3	4	5	6	Total
Number of records	3	-	5	5	7	2	2	24
Percentage	12.5	-	20.8	20.8	29.3	8.3	8.3	100%

Weather Condition	b	bc	c	Total	Remarks
Number of records	1	17	6	24	b : fine bc: fine but cloudy
Percentage	4.2	70.8	25.0	100	c : cloudy

At the Bonto Marannu, the wind of SE-SSE is indicated as 62.4% of the total records due to the SE monsoon season.

The weather condition is recorded as 75% of fine, 25% of cloudy sky and 0% of rain.

It was observed at the Bonto Marannu inshore portion by the visual survey that the wind force of SE or SSE becomes strong from around 10 AM and it increases up to 4-5 around 2 PM, then the wave height reaches 2-2.5 m. This strong wind becomes weak in the dark and calm sea condition continues up to the next morning.

The wind force, wind direction and weather condition of the offshore portion between Takisung and Bonto Marannu were observed during the going run (2nd-5th July) and return run (12th-19th July) survey.

The recorded data are as follows.

Wind Direction	ESE	SE	SSE	S	SSW	W	NW	NNW	NW	E	Total
Number of records	7	40	14	5	1	1	1	1	1	1	72
Percentage	9.7	55.6	19.4	6.9	1.4	1.4	1.4	1.4	1.4	1.4	100

Wind Force	2	3	4	5	6	Total
Number of records	4	28	20	19	1	74
Percentage	5.6	38.9	27.7	26.4	1.4	100

Wind Force	b	bc	c	*O	r	Total
Number of records	1	56	6	5	4	74
Percentage	1.4	77.9	8.3	6.9	5.5	100

The wind direction was mostly ESE-SE-SSE and another direction was rare. As to the wind force, 2-3 beaufort scale was recorded as 45% and 4-6 of strong wind was 55%. Due to this strong wind of 4-6, the sea condition became wrong with 2-3 m wave hight. The weather condition was mostly fine and cloudy sky or over cast weather was recorded as 15%. The rainfall was rare but squall was recorded several times.

1.4 Fishing Activities

More than 60% of submarine cable damages occured on the continental shelf where the sea depth is less than 200 m. Such damages are caused by almost trawl fishing and anchoring of vessels.

The submarine cable between Kalimantan and Sulawesi will be laid on the Jawa Shelf and Sulawesi Shelf, therefore, there are some possibility of cable damages due to the fishing activities. However, the trawling fishing is prohibited by the law of the Government of the Republic of Indonesia, so that possibility of cable damage seems to be low in compare with that of other continental shelf.

During the survey period, so many fishing boats were observed at the inshore portion of both cable landing sites and offshore portion.

At the Takisung inshore portion, it was observed that fishing boats of 1-2 ton's size were working to catch fishes by a gillnet and the number of such fishing boats was counted 10 within 2 nm around the survey ship which was moving along the planned cable route. The pulling direction of the gillnet was right angle to the coast line of Takisung. And no set net and fixed fishing instruments were observed at the Takisung inshore portion.

At the Bonto Marannu inshore portion, it was also observed that the fishing boats 1-2 ton's size were operating at 2-3 nm offing of the coast line to catch fishes by a line fishing and the number of such fishing boats was counted about 20-30. And also no set net and fixed fishing instruments were observed at the Bonto Marannu inshore portion.

At the offshore portion of cable ground, 20-30 ton's fishing boats was in operation with a line fishing and gillnet. However, Attention must be paid to the fact that such fishing boats were using their anchor for keeping their position during fishing and pulling net. Such anchoring will be a cause of cable damage. Accordingly, it might be necessary to make a notice of the submarine cable laying to the fishing ports facing Jawa Sea and the west coast of Sulawesi.

1.5 Shipping Activities

Concerning the both cable landing sites of Takisung and Bonto Marannu, there are the port of Banjarmasin and Ujung Pandang at northward. But the each distance from both landing sites to both ports is rather far. Therefore the possibility of a cable damage caused by ship's anchoring might be low. The cable route connecting the both cable landing sites crosses the Makassar Strait. This Strait is connected to the Pacific Ocean via the Sulawesi Sea and the southern part of Mindanao Island at northern direction, and to the Jawa Sea at southern direction. Then furthermore, the Jawa Sea is connected to the Malacca Strait at western direction and to the Flores Sea at eastern direction.

Accordingly, the Makasar Strait is an important passage for many merchant and cargo vessels. The cable route also crosses the passages of the Indonesia local ships which sail between and among the Islands.

On the cable laying operating by a cable ship, it may be necessary to make a notice of the cable ship activity in advance of cable laying because the cable ship cannot change her head direction during the laying.

Table 1-3 shows the number of vessels which were observed during the survey period.

Table 1-3 Vessel Encountered during Survey Work (going/return run)

	Takisung-115°	115°-116°	116°-117°	117°-118°	118°-119°	119° Bonto Marannu
Large Vessel (under going)	3	5	1	9	0	3
Small Vessel (under going)	11	11	10	3	1	3
Fishing Boat (in operation)	16	7	40	14	2	57
Total	30	25	51	26	3	63
Mean Number of Vessel Encountered per day	68	12.8	20.4	8.7	1.7	17.5

Large Vessel: Ocean going vessel (eg. Cargo, Passenger, Tanker, Ore carrier, etc.)

Small Vessel: Coasting boat (Cargo, Tug boat, Barge, Local sailing boat)

Fishing Boat: in operation (Gill net, Line fishing, etc.)

1.6 Offshore Oil Activities

The petroleum exploitations along the coast of Jawa Sea are underway at so many places, especially in its southern part. Along the submarine cable ground of Kalimantan-Sulawesi, there are four petroleum developing areas as shown on Fig. 1-4. But no exploration activity is going on at present. However, PERTAMINA is planning to commence the petroleum exploration at the SE coast of Kalimantan in near future. Therefore, the activities of such oil companies must be watched for this submarine cable project.

As regard to natural resources in the deep area of Makassar strait might be an objective field in future. And the dredging of such materials from the seabed will give some effects to the laid submarine cable.

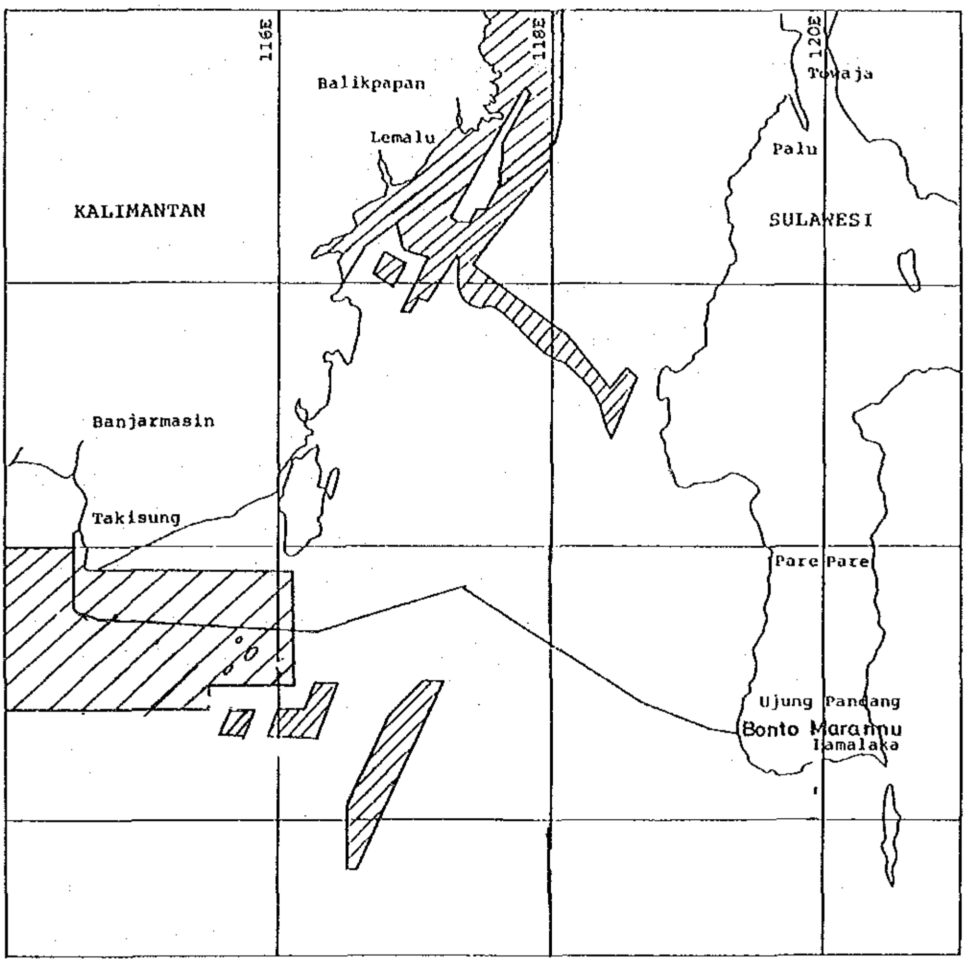


Fig. 1-4 Petroleum Developing Mining Areas

1.7 Mine Area

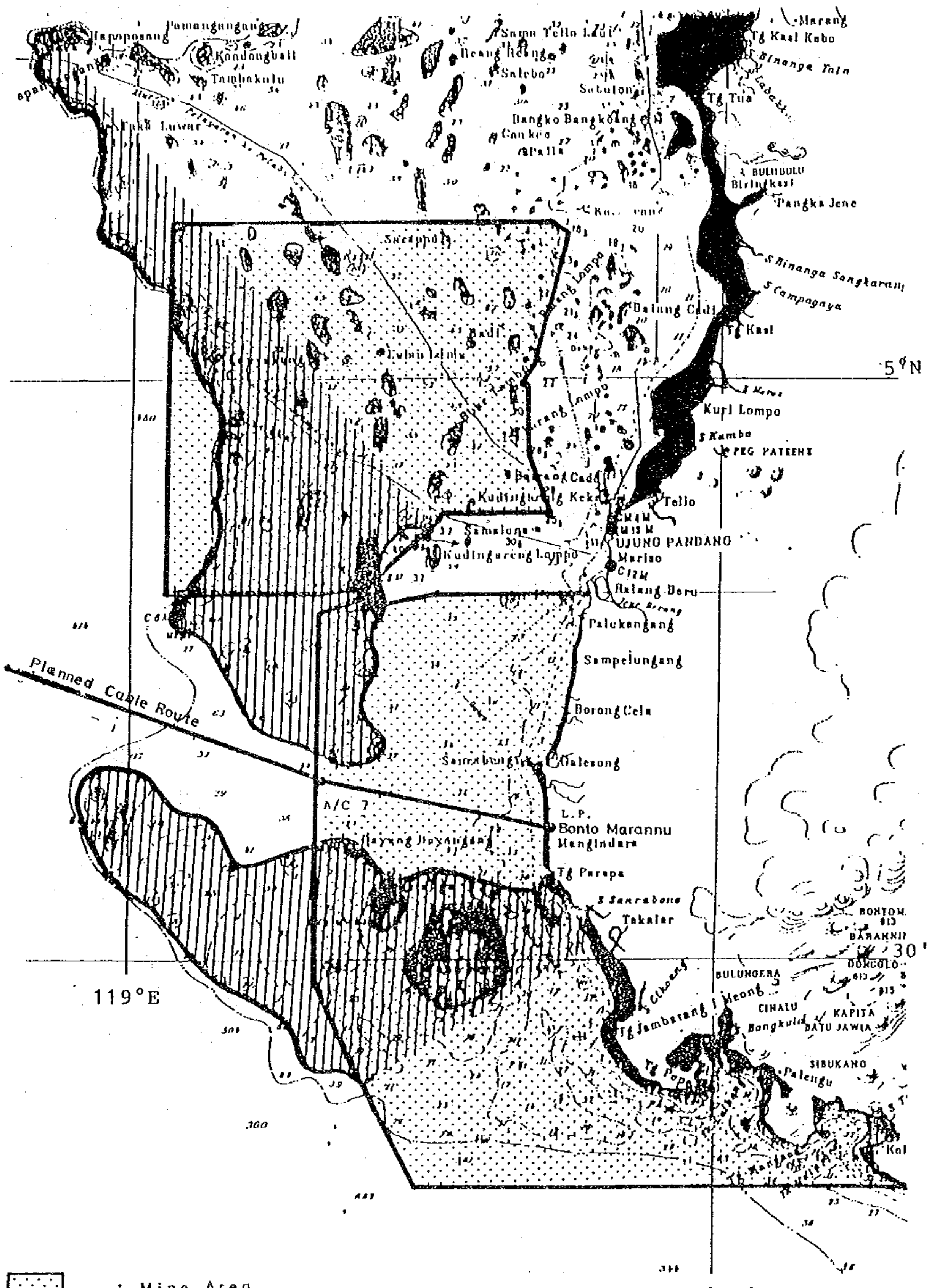
Along the planned submarine cable route between Kalimantan-Sulawesi, there is an un-swept mine area at the Sulawesi continental shelf as shown in Fig. 1-5.

To approach the cable landing site at Bonto Marannu, the cable route cannot avoid passing through the mine area. The length of the cable route in the mine area is about 20 km.

The mines dropped in the area were performed during the Second World War, therefore mines have been slept more than 40 years into or on the sea bottom.

Accordingly, it can be said that electrical function of mine might be dead, but the mechanical function of them might be alive with a low possibility. From this point of view, the spot magnetic mine search was carried out on the survey of the mine area at the specified points where the ship's anchor and survey instruments touch or penetrate the sea bottom. During the survey works in the mine area, magnetic sensor used for spot mine search, detected no mine at the specified points.

On the cable landing and laying operation in this mine area, there is some possibility of explosion of mine in case of the cable or some instrument touching directly to mine. Therefore it is recommended that the mine search along the cable route should be carried out in advance of the cable landing and laying operation.



: Mine Area

: Reef Area

Fig. 1-5 Mine Area

Depth in meter

1.8 Earthquake Activities

Due to the squeezing action of the Eurasian, Australian and Pacific Plates, there are a lot of volcanic activities and earthquakes in the area around the Jawa Trench.

According to the seismic danger map of the world seismic activities zones, the north area of Sulawesi was listed up.

As to the cable ground of Kalimantan-Sulawesi cable, Sulawesi is designated as an earthquake danger zone.

The number of earthquakes observed at seismological observatory near Makassar Strait are annouced by Station Geofisika Gowa in 1985. According to this statistics, the number of seismic perception at Ujung Pandang in 1985 is 933 times.

The Bonto Marannu cable landing site is located at 30 km south of Ujung Pandang, therefore some secondary effect of the earthquake must be considered on the structure of the landing station building and also terminal equipments etc.

On August 14th 1968, Magnitude of 7.75 earthquake occurred at the offing of Palu and the tidal wave of 3 m height attacked coast area. If such a large scale earthquake would occur under the bottom of deep water portion of the Makassar Strait, the Bonto Marannu landing site will be attacked by the tidal wave. Therefore, some countermeasure shall be taken on the shore end and land cable. The Kalimantan side, there is no such serious earthquake record up to present.

1.9 Fish Bite

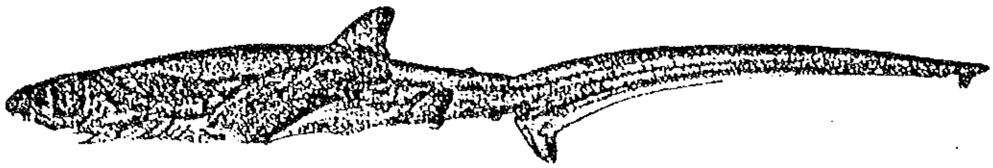
It was reported by AT & T in 1980 that the optical fiber submarine cable was bitten by a shark and the cable became faulty.

Since that time, a countermeasure against shark bite has been applied on the deep sea cable and also an investigation on sharks living status became one of the important items of optical fiber submarine cable route study.

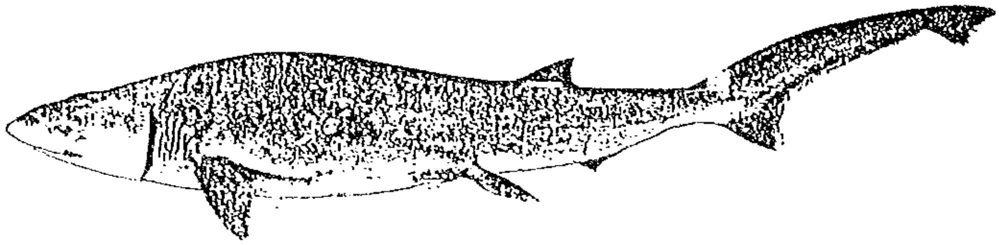
The submarine cable route between Kalimantan and Sulawesi pass through the Makassar Strait. In this Strait, several kinds of sharks are living, such as Centrophorus atromargi-nantus (A), Heptranchias perlo (B), Alopias superciliosus (C), Isurus oxyrinchus Rafinesque (D). The sharks of (A) and (B) are living in the depth of 300-400 m and keep rich oil in their body. This shark oil is exported from Ujung Pandang to Japan. The Shark of (C) is living in more deep water of 500 m. The shark of (D) is living in shallow water portion and sometimes it attacks a man. The figure of these sharks is shown on Fig. 1-6.

As described above, there are so many sharks in the Makassar Strait. Therefore some countermeasure should be taken on the deep sea cable to be protected from sharks bite.

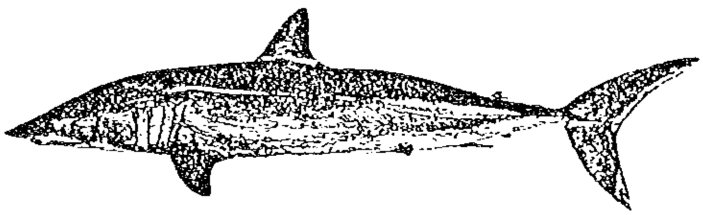
Heptranchias perlo (B)



Alopias superciliosus (C)



Centrophorus atromaginatus (A)



Isurus oxyinchus Rafinesque (D)

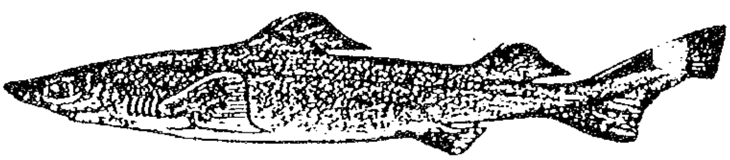


Fig. 1-6 Sharks Living in Makassar Strait

CHAPTER 2 INSHORE SURVEY AND LANDING SITE SURVEY

CHAPTER 2 INSHORE SURVEY AND LANDING SITE SURVEY

2.1 General

Prior to the inshore survey, the Phase II Study Team has carried out the field survey of both cable landing sites with cooperation of POSTEL and PERUMTEL from 20th to 24th April 1988. The main objective of this field survey was to determine the cable landing point at both cable landing sites which were selected by the Phase I Study Team in the presence of personnel of POSTEL and PERUMTEL.

Concerning the cable landing point at Takisung, it was arranged that the cable landing point for the Kalimantan-Sulawesi Submarine Cable would be the same landing point of the Surabaya - Banjarmasin Submarine Cable which was selected by JICA on February, 1986.

However, on the field survey of Takisung landing site, it was proposed by PERUMTEL (WITEL IX) that the cable landing point shall be moved 190 m to the southward due to the position of land space for construction of the cable landing station. The Study Team has accepted this proposal after investigation of the land space, and determined the new landing point which was located about 190 m south of the previous one.

In advance of starting the Takisung inshore survey, the Study Team has confirmed to POSTEL and PERUMTEL that the inshore survey at Takisung shall be carried out by setting up the base point at the new landing point.

During the initial stage of Takisung inshore survey, it was found on the planned cable route that rock outcrops appeared at the seabottom about 1500 m off the beach. Therefore, the shore end cable route was changed about 2° to northern direction to avoid this rock outcrops.

As to the cable landing site at Bonto Marannu, the landing point was determined at the front beach of the planned cable landing station area in the presence of POSTEL and PERUMTEL personnel at the field survey. Therefore, the inshore survey at the Bonto Marannu was carried out by setting up the base point at the determined landing point.

This chapter describes the result of the landing sites and inshore survey, in order to select a safety cable route for the construction and maintenance.

The vessels used on this survey were Wakasio Maru (500 tons) and local chartered boats of about 10 tons. Table 2-1 shows the conducted survey items and their objectives.

Table 2-1 Survey Items and Objectives

Item	Objectives
Control Point Survey	* To obtaine the geographical position of the landing point for cable laying * To determine the direction of cable route and obtaining the direction of survey lines
Seabed Profiling	* To clarify the seabed topography along cable route for cable laying and security * To obtain the seabed profile * To clarify the topography around the cable route
Seabed Scanning	* To confirm the presence of any obstacles, e.g. rocks, sunken ships, etc. * To clarify micro-topography and seabed material
Sub-Bottom Profiling	* To clarify the geological structure in the upper part under seabed * To clarify the hazardous outcropped areas for the cable security after due consideration seabed scanning results * To confirm the possibility of cable burying * To obtain the sub-bottom profile along the cable route
Bottom Sampling	* To clarify the nature of bottom materials by visual observation, physical test and chemical test * To compare and confirm the data obtained by the seabed scanning and sub-bottom profiling

2.2 Takisung

2.2.1 Outline of Survey

The inshore survey and landing site survey at Takisung were conducted on the items shown on Table 2-2.

The detailed survey instruments and means are shown on Appendix 3.

Table 2-2 Outline of Survey Contents

	Survey Items	Instrument	Survey Range
Landing Site Survey	Control Point Survey	GPS, Theodolite Electro Optical Distance Meter	Beach Area
	Topographic Survey	Level	Between L.P and Landing Station Tidal Zone
Inshore Survey	Positioning	Microwave Ranging System	500-5000 m offing of L.P
	Seabed Profiling	Echo Sounder	Tidal Zone 5000 m
	Seabed Scanning	Side Scan Sonar	500-5000 m offing off L.P
	Sub-bottom Profiling	Sub-bottom Profiler, Steel Rod	500-5000 m offing of L.P 6 points at 500-5000 m off L.P
	Sea Bottom Sampling	Diver	6 points at 500-5000 m off L.P

2.2.2 Landing Site Survey

The landing site on Kalimantan has been planned at the coast of Takisung located about 63 km southward apart from Banjarmasin.

The topography around landing site and the profile along the land cable route are shown in Fig. 2-1. There is a river mouth that flows into the sea from the small river of Sungai Kalingaian at about 350 m northward of the landing point. And the shore line with sand beach extends from south to north.

The Takisung landing point (T.L.P) has been established at a place 10 m toward inland from shore line, located a little higher than around area.

The main road which passes through Pelahari, runs 170 m backward of T.L.P and the houses of local people are scattered on the both sides of this road. The topographic feature around T.L.P is a flat and lowland, consisting of a marsh, rice fields and copse.

There is a marsh extending along the beach about 40 m northward of T.L.P.

The cable landing station has been planned to construct at a site 100 m ENEward from T.L.P.

A topographic profile between T.L.P and the planned station shows a low ground with a little difference of height.

The variation of height from high water level along the land route is -0.2 m to +1.0 m and the heights of T.L.P are +3.9 m on the low water level and +0.7 on the high water level.

At the time of the lowest low water, shore line goes to offshoreward about 80 m.

The position of T.L.P was determined by the following way. The ship's position was fixed by means of GPS and at the same time, a distance between the ship and T.L.P was accurately measured using the microwave ranging system.

After completion of the above-mentioned measurement, the ship shifts to next point of several kilometers from initial fixed point, and the measurement were done at 3 points in total. The position of T.L.P was calculated by the trilateration method.

The latitude and longitude of T.L.P is as follows:

Latitude (S): 03° 52'.42
Longitude (E): 114° 36'.61

A concrete mark has been buried as the control point at T.L.P. The angle at T.L.P between the selected route and the top of bare rock at offing is shown in Fig. 2-2.

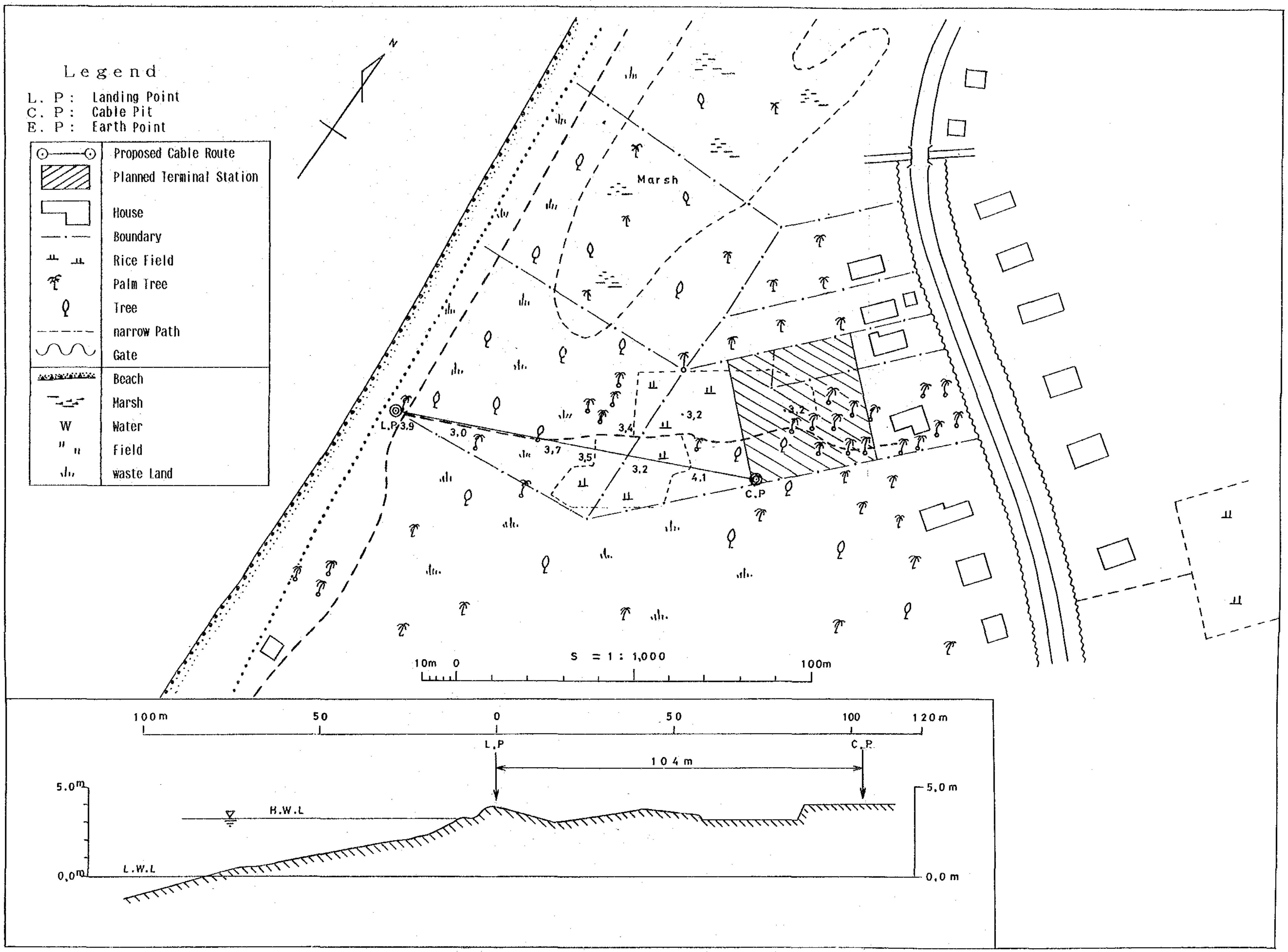


Fig. 2-1 Topography Around Landing Site in Takisung

POint	WGS — 72	
	Lotitude	Longitude
L.P	5° 52,42	114° 36,61
C.P	5° 52,40	114° 36,66

L.P : Laniding point

C.P : Cable pit

1 = 70° 50′ 0.0″

2 = 225° 13′ 30″

3 = 246° 39′ 20″

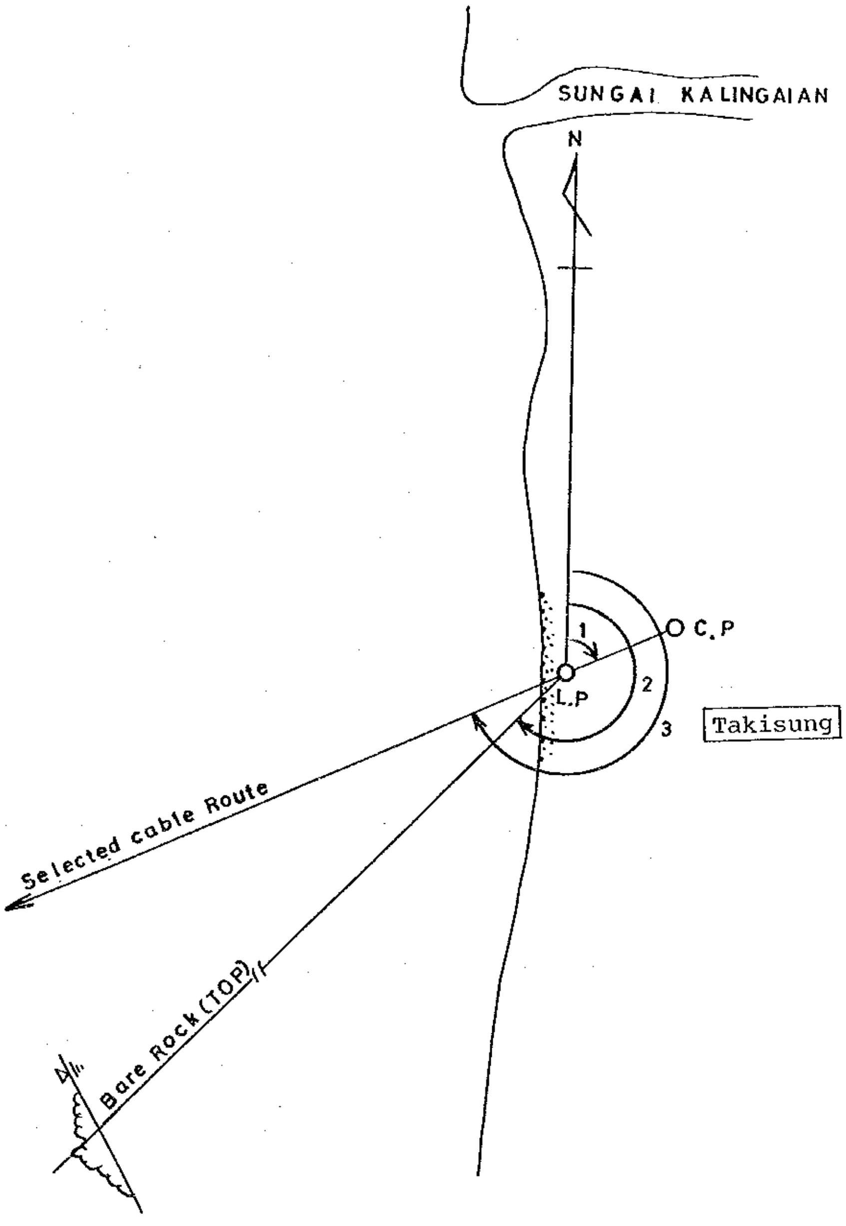


Fig. 2-2 Bearings of Cable Route in Takisung

2.2.3 Submarine Topography and Geology

The inshore survey at Takisung was done up to 5000 m offing of the cable landing site.

Fig. 2-3 shows the seabed topography in the survey area (0.2 km x 5 km), and Fig. 2-4 shows the sub-bottom profile along the selected cable route. And also, Table 2-3 indicates the seabed gradient along the route.

Table 2-3 Seabed Gradient Along Selected Cable Route

Distance (m) from Landing Point	L.P. 0		20		160		1420		1960		3260		5000
Gradient		1/13		1/60		1/120		1/500		1/650		1/950	
Height (Depth) (m)	+3.9		+2.3		0		-1		-4		-6		-7.8

As far as the gradient of submarine topography concerned, it was quite gentle except near the cable landing point.

However, according to the record of the Side Scan Sonar, the rock outcrops were observed near the selected cable route as shown on Fig. 2-5.

Figure 2-4 shows the sub-bottom profile along the selected cable route.

1/10000 (Lat. 5°S WGS-72)

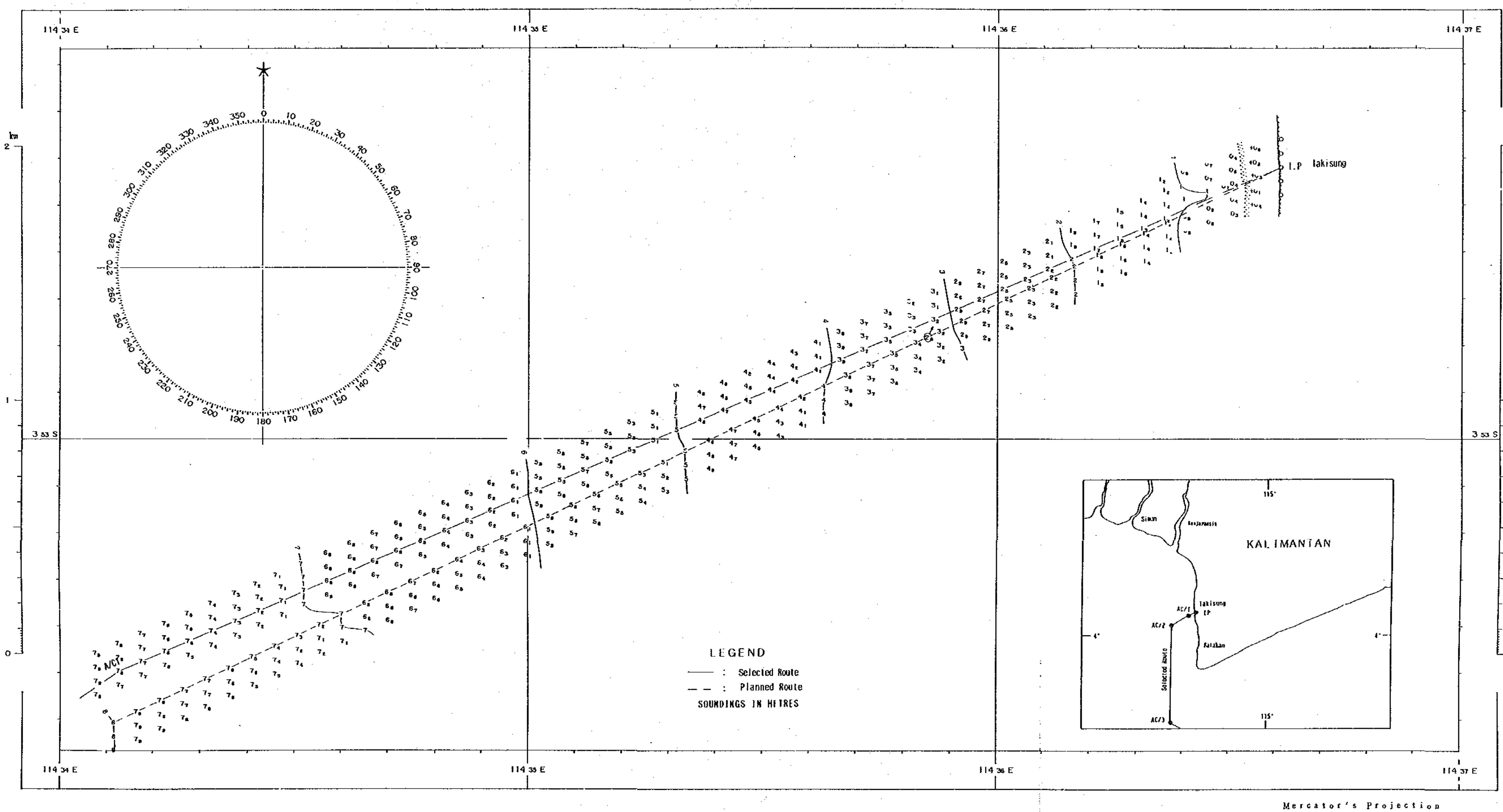


Fig. 2-3 Bathymetric and Contour Chart Off Takisung

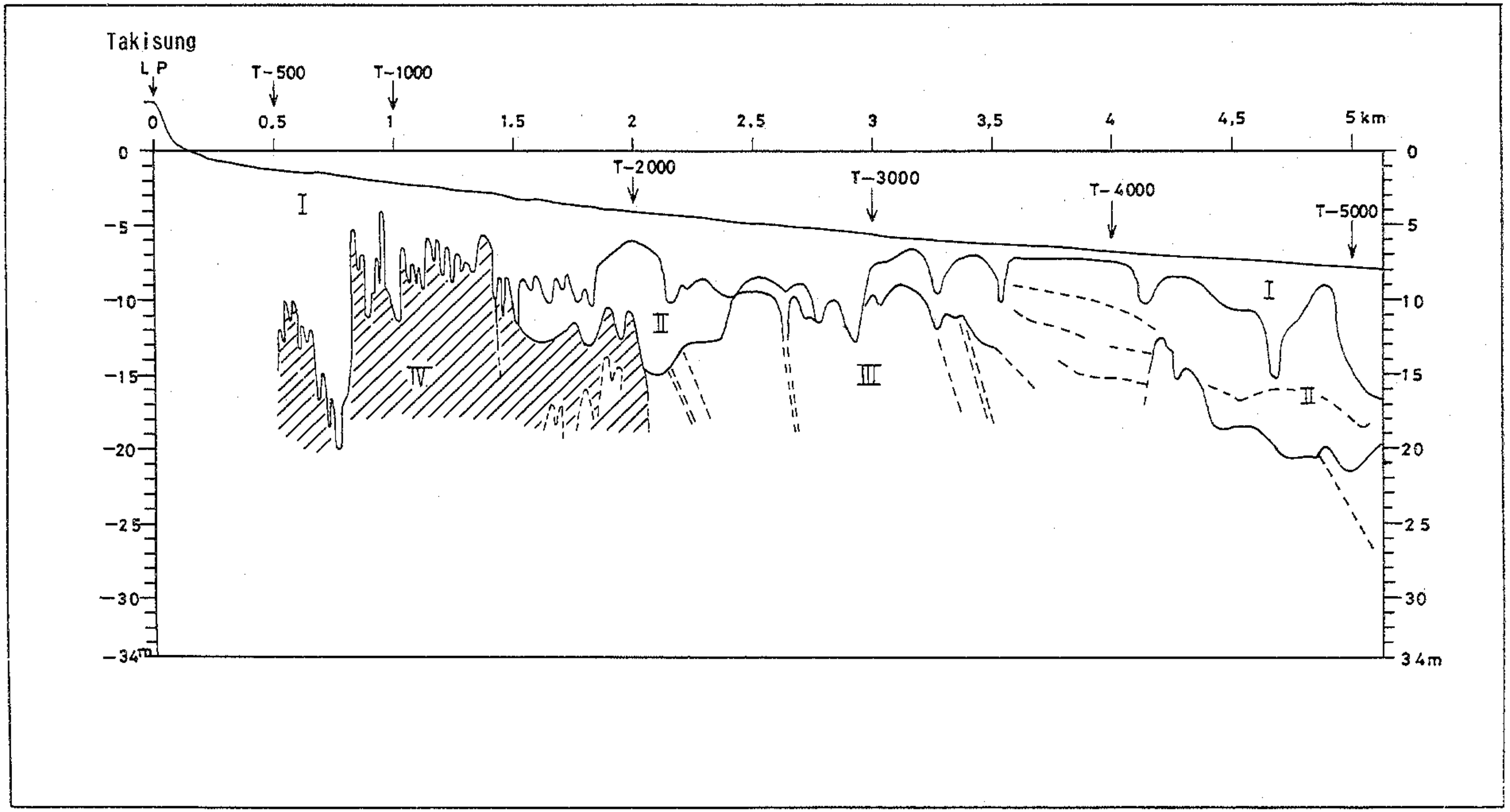


Fig. 2-4 Seabed and Sub-bottom Profile in Inshore Area (Takisung)

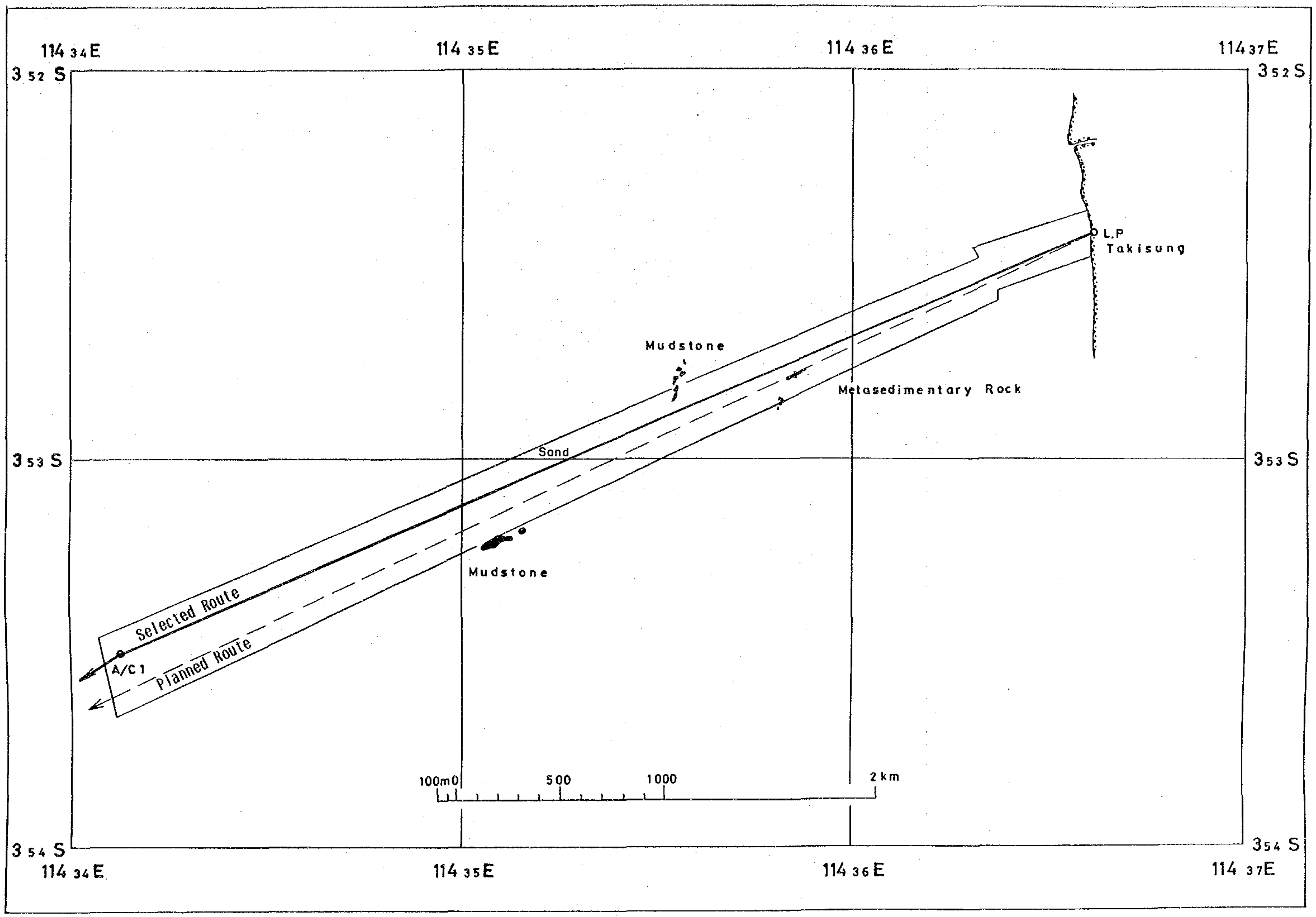


Fig. 2-5 Distribution of Outcrops (Takisung Approach)

From this result, it becomes clear that the sub-bottom geological condition is composed of the rocks (IV layer) with rough surface and without bedding plane (up to 2000 m from T.L.P), and the sedimentary rocks (III layer) with clear bedding plane (offing more than 2000 m from T.L.P) rock. The former basement rock is seemed to be the metasedimentary rock which appeared on the seabed at near beach and 1500 m offing of the beach. This basement rock is covered with stiff and sticky clay (II layer) and also is covered also by mud and clay (I layer).

The II layer, lacks at many parts up to 2000 m off T.L.P. However, some part of offing more than 2000 m, the thickness of II layer reaches more than 10 meters. The thickness of I layer is depending on the up and down of the II layer and basement rocks.

Along the selected cable route, the thickness of I layer is reached nearly 10 meter at some part, but the area of 1100 m, 1430 m, 2000 m, 3100-3150 m and 3400 m from T.L.P, the II layer or IV layer approaches to the seabed. In these area, the thickness of the I layer is less than one meter.

Table 2-4 shows the results of bottom sampling and steel pipe penetration test by divers.

According to the result of this, the seabed surface is a thin floating mud and this forms an upper portion of the I layer. The penetrating depth of the steel pipe is almost 100 cm except 70 cm at 4000 m offing of T.L.P.

Table 2-4 Results of Bottom Sampling and Steel Pipe Penetration Test

Sampling Point (Distance from L.P.)	Bottom Material	Penetrating Depth of Steel Pipe
500 m	Mud	1.0 m<
1000 m	"	"
2000 m	"	"
3000 m	Clay	"
4000 m	"	0.7 m
5000 m	"	1.0 m<

As described above, there are no difficulties to lay the cable along the selected cable route from the view point of submarine topography and geology. However, near the cable route, there are the outcrops of the metasedimentary rock and the stiff clay. Therefore it might be required to pay attention to the positioning on the cable landing and laying operation.

As to the cable burying, it is considered that the cable burying works will take a time due to the thin soft sedimentary layer at several areas. And also, it is necessary to bury the shore-end cable much deeper against the beach erosion which was observed on the field survey.

2.2.4 Currents and Water Temperature

(1) Currents

The current observations at the Takisung inshore area were not conducted at this time, because it had been conducted at the time of the Surabaya - Banjarmasin Cable Route Survey on February, 1986, by JICA. The following description and data was abstracted from the report.

"The 3 days continuous observation had been made at station B-1 located about 3.5 km westward of the landing point with water depth 9.8 m.

According to the data, the currents at the surface and bottom layer dominate in south and north direction. The max, and mean velocities of the currents were listed on the following table.

* Current Velocity (Feb. 1986) St. B-1

Layer \ Velocity	max	mean
0.5 m under surface	45.7 cm/s	25.8 cm/s
1 m above seabottom	39.3 cm/s	16.1 cm/s

(2) Water Temperature

The Water Temperature Measurement was carried out at 6 points in the Takisung inshore area from 10:29 to 12:04 on July 1st. The temperatures obtained at whole stations were recorded in the range between 26.9 and 27.5°C from sea surface to seabed. Every stations were located along the route at intervals 1 km except interval 0.5 km between T-500 and T-1000.

The water temperature value at the sea surface (0.5 m under sea surface) and bottom layer (1 m above sea bottom) were listed on the following table.

Water Temperature at Takisung (Observed on July 1st, 1988)

Station No.	T-500	T-1000	T-2000	T-3000	T-4000	T-5000
0.5 m under surface (°C)	26.9	26.9	27.1	27.4	27.4	27.5
1 m above seabed (°C)	26.9	26.9	26.9	27.4	27.4	27.4
Depth (m)	1.2	2.2	4.1	5.7	6.8	7.8

Examining the water temperature variation in vertical section using Fig. 2-6, the variation of water temperature in vertical section from surface to bottom were scarcely observed. However, by examining the obtained values at each station, the values at the stations near the shore was 0.5-0.6°C lower than that of offing.

The reason for this seems to be due to a low temperature of river water flowing into the sea and to be the water-masses difference between near shore and offing.

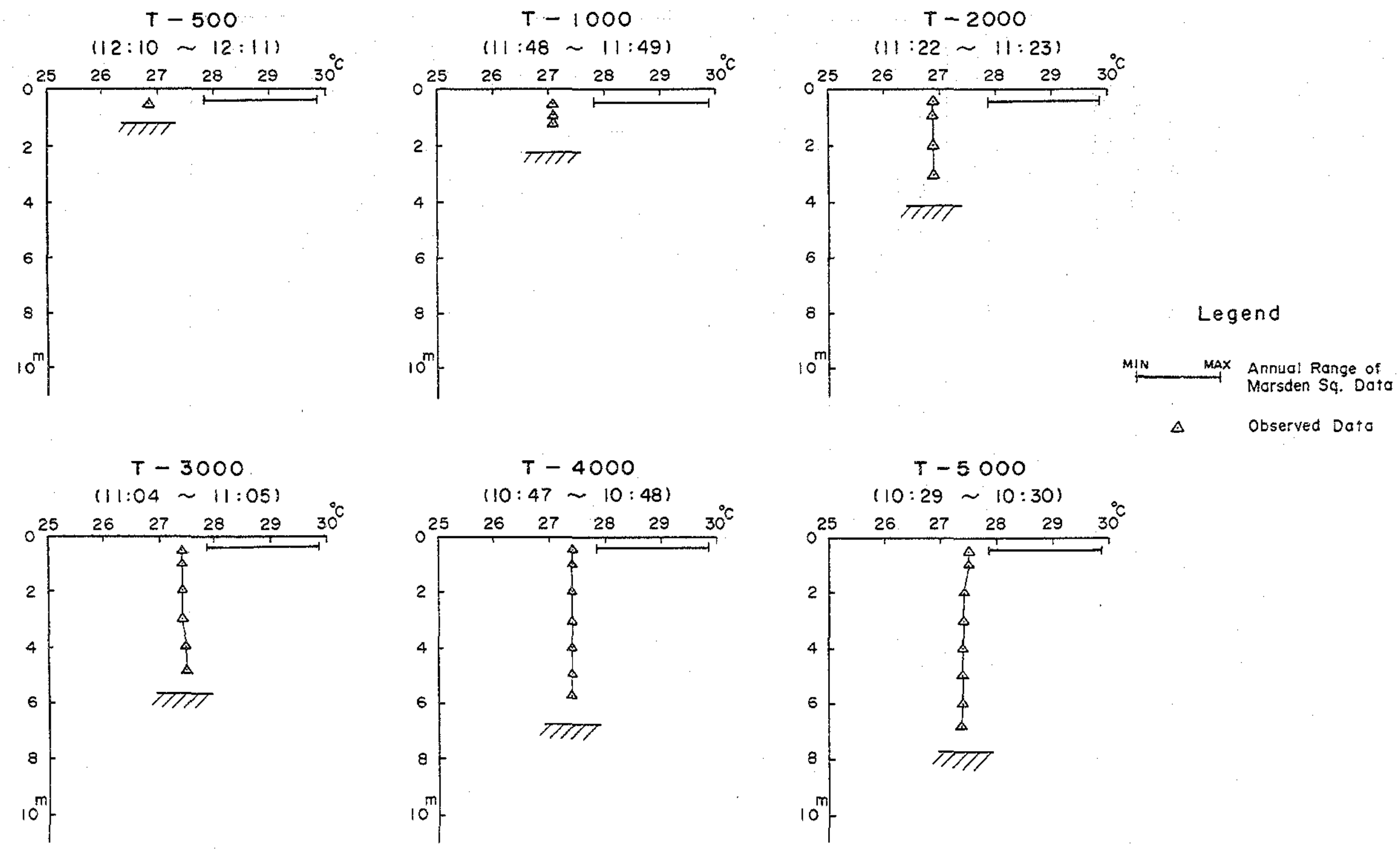


Fig. 2-6 Water Temperature at Takisung Inshore (July 1, 1988)

2.3 Bonto Marannu

2.3.1 Outline of Survey

The inshore and landing site survey at Bonto Marannu were conducted on the items shown on Table 2-5. The detailed survey instruments and means are described on Appendix 3.

Table 2-5 Outline of Survey Contents

	Survey Items	Instrument	Survey Range
Landing Site Survey	Control Point Survey	GPS, Theodolite Electro Optical Distance Meter	Beach Area
	Topographic Survey	Level	Between L.P and landing Station Tidal Zone
	Earth Resistivity Measurement	Earth Resistance Meter	Beach Area
Inshore Survey	Positioning	Microwave Ranging System	500-5000 m offing of L.P
	Seabed Profiling	Echo Sounder	Todal Zone 5000 m
	Seabed Scanning	Side Scan Sonar	500-5000 m offing of L.P
	Sub-bottom Profiling	Sub-bottom Profiler, Steel Rod	500-5000 m offing of L.P 6 points at 500-5000 m off L.P
	Sea Bottom Sampling	by Diver	6 points at 500-5000 m off L.P
	Mine Search	Magnetic Prospector	6 points at 500-5000 m off L.P

2.3.2 Landing Site Survey

Bonto Marannu, the cable landing site of Sulawesi Island, locates about 30 km southward of Ujung Pandang. A road passing through Bonto Marannu has still not been paved but automobiles are able to run on the road.

Topography and profile at the landing site are shown in Fig. 2-7.

The coast around the Bonto Marannu landing point (B.L.P) consists of a sand beach and extends from south to north.

The B.L.P has been established at the highest point (1 m above height water level) around the area.

There are two conspicuous palm trees at beach line in front of B.L.P. Since the beach is washed away by wave at the time of a high water tide, it seems to be that the beach is eroding. The topographic feature around B.L.P is a flat and low land consisted of swamp and rice field.

The planned construction area of the cable terminal station locates in the rice field 230 m away from B.L.P and faces on the main road.

According to the profile between B.L.P and the planned cable terminal station, the ground level along the land route is almost same or lower than water level at the time of high water except B.L.P.

The position of B.L.P was fixed by using a GPS. And the azimuth at B.L.P was obtained by the solar sight in the astronomical observation. A concrete mark has been buried at B.L.P.

The latitude and longitude of B.L.P are as follows:

Latitude (S): 5° 23'.74
Longitude (E): 119° 21'.53

The angle at B.L.P between the selected cable route and Dayangdangan light house is shown in Fig. 2-8.

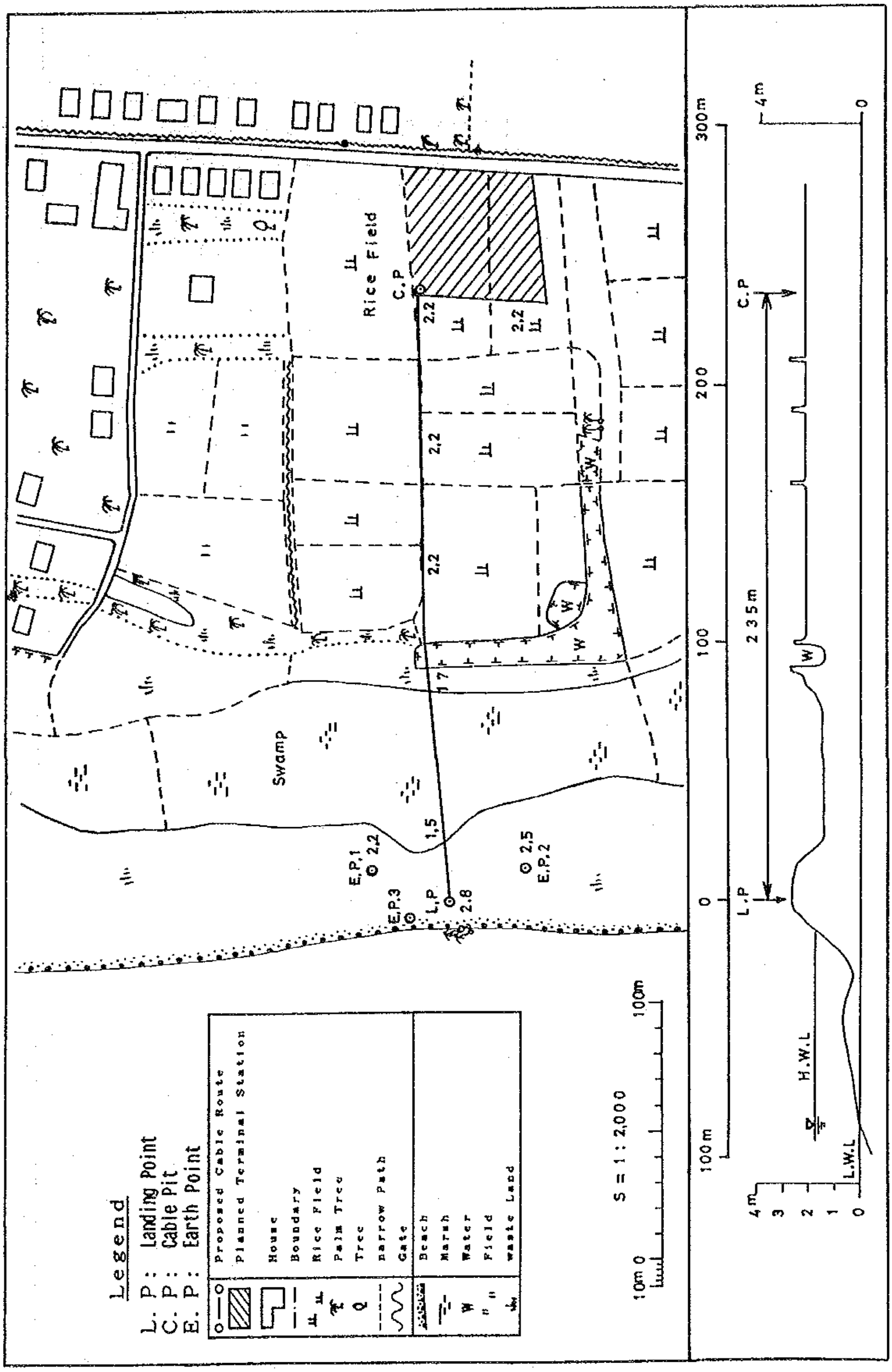


Fig. 2-7 Topography Around Landing Site in Bonto Marannu

POint	WGS — 72	
	Lotitude	Longitude
L . P	5° 23,74	119° 21,53
C . P	5° 23,72	119° 21,56

L.P : Laniding point

C.P : Cable Pit

1 = 87° 18'.01"

2 = 269° 36' 40"

3 = 284° 16' 16"

4 = 356° 26' 50"

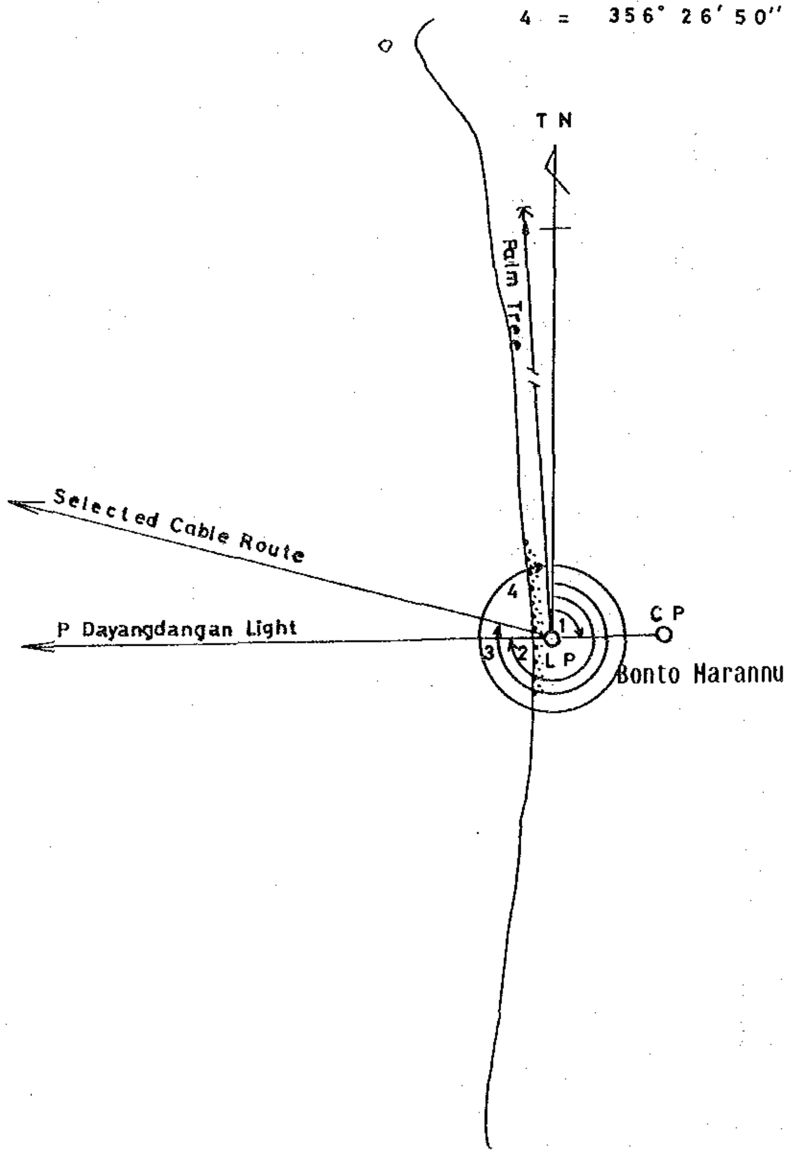


Fig. 2-8 Bearings of Cable Route in Bonto Marannu

2.3.3 Submarine Topography and Geology

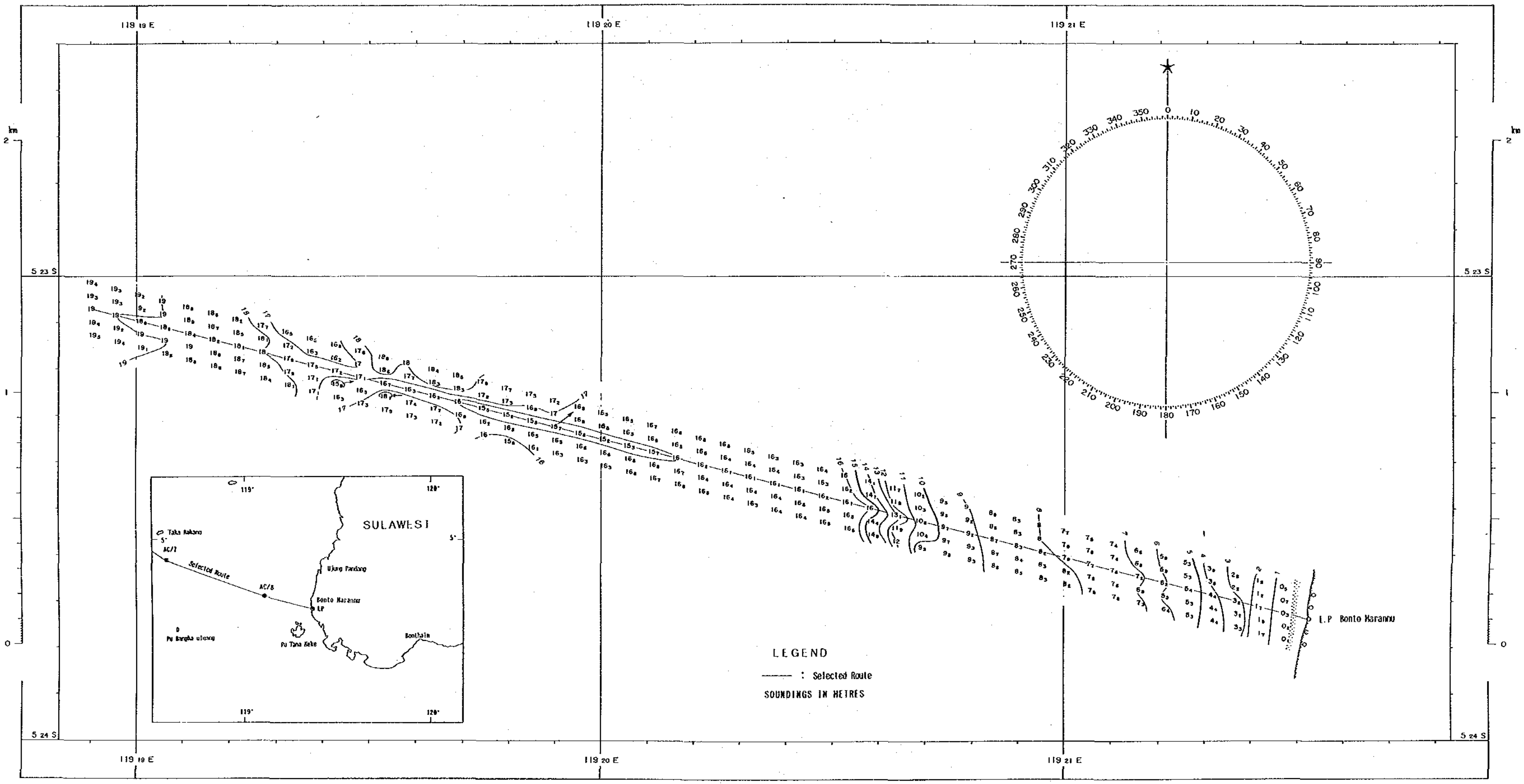
The inshore survey at Bonto Marannu was done up to 5,000 m offing of the cable landing point as same as that of Takisung. Fig. 2-9 shows the seabed topography in the survey area (0.2 km x 5 km), and Fig. 2-10 shows the sub-bottom profile along the selected cable route. And also the Table 2-6 indicates the seabed gradient of the route.

Table 2-6 Seabed Gradient of Selected Route

Distance from Landing Point	L.P. 0		km 0.25		0.7		1.2		1.6		1.8		2.5		3.5		5.0
Gradient		1/40		1/110		1/500		1/150		1/40		flat		(two mounds)		1/500	
Height (Depth)	+2.8		-3.2		-7.3		-8.3		-11		-16		-16		-16		-15

As shown on Table 2-6, the seabed gradient from the landing point up to 1.8 km is comparatively steep. Then, in the section between 1.8 km and 3.5 km from B.L.P, the seabed topography is a flat except two mounds located at 2.9 km and 3.5 km from B.L.P. As to the reason of existence of these two mounds, it seems to be born by the up and down of the basement rocks.

The offing of 3.5 km from B.L.P, the seabed topography is gentle slope with gradient of 1/500 and sea depth increase gradually. At the 5,000 m apart from the cable landing point, the sea depth reaches to 19 m. The result of seabed scanning in this area, there is no significant information except the steep slope existed at 1600-1800 m from the landing point.



Mercator's Projection

Fig. 2-9 Bathymetric and Contour Chart Off Bonto Marannu

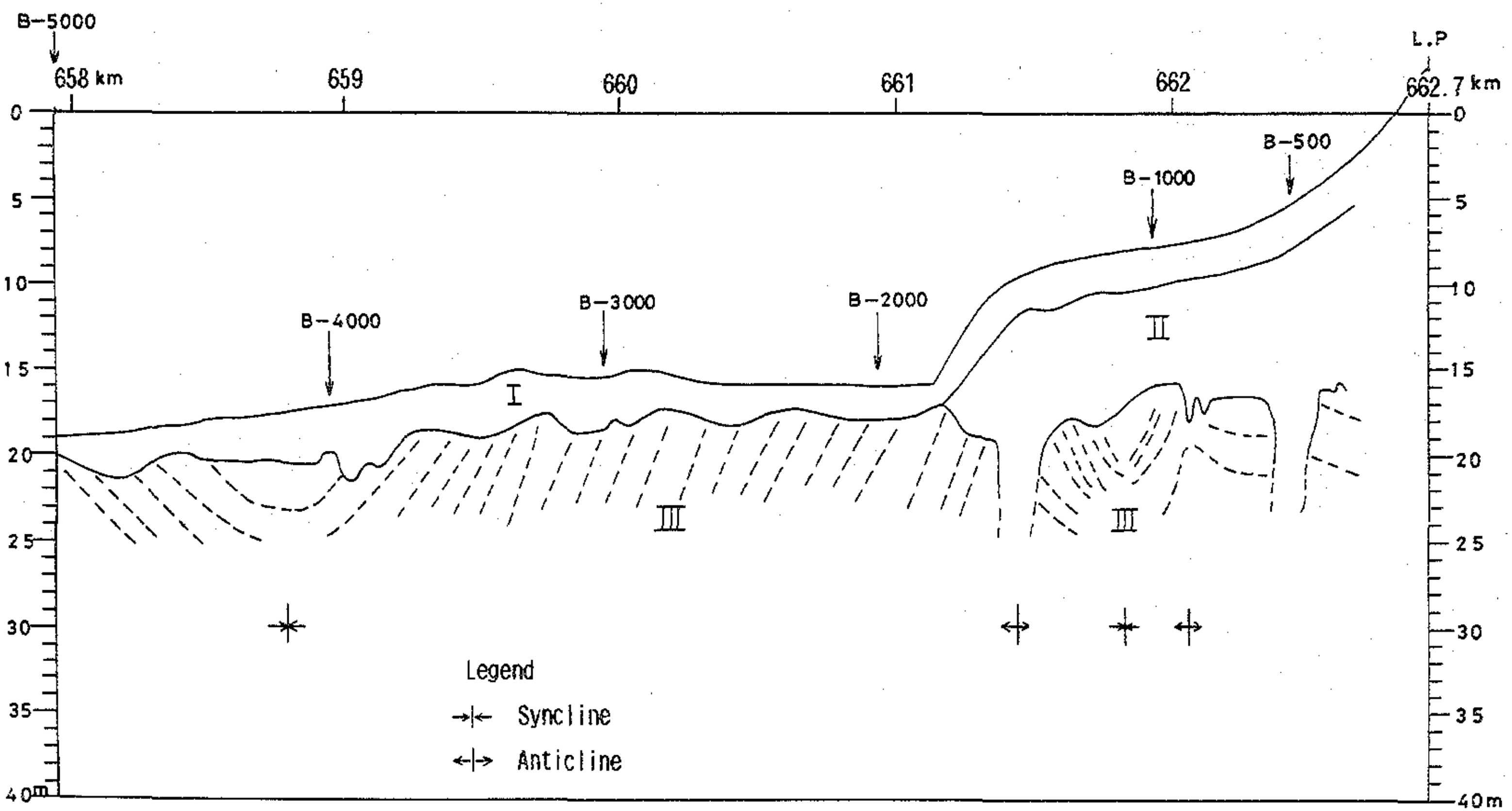


Fig. 2-10 Seabed and Sub-bottom Profile in Inshore Area (Bonto Marannu)

As to the Sub-bottom configurations, the basement rocks consist of the sedimentary rock with comparatively clear bedding plane (III layer). This sedimentary rock is presumed as the alternation of sand and mud layer through the records of sub-bottom profiler. And also, in this basement rocks, many faults and foldings which were formed by the earth crustal movement, are observed. This basement rocks were covered by a mud bed (II layer), then the II layer is covered by sand layer (I layer) which appears on the seabed up to 1750 m apart from B.L.P. However, at the offing of 1750 m, the layer I is directly laid on the III layer due to the lack of II layer. The thickness of layer I in this area is 1.5-3 meters, but in the offing of 1750 m from B.L.P, the thickness varies by the up and down of III layer.

According to the steel pipe penetration test, it was confirmed that the penetrating depth into the sand layer was more than 1 meter at each point as shown on Table 2-7.

Table 2-7 Result of Steel Pipe Penetration Test

Sampling Point (Distance from L.P.)	Bottom Material	Penetrating Depth of Steel Pipe
500 m	Sand	0.7 m
1000 m	Sand	1.0 <
2000 m	Muddy Sand	1.0 <
3000 m	Fine Sand	1.0 <
4000 m	Muddy Sand	1.0 <
5000 m	Muddy Sand	1.0 <

2.3.4 Current and Water Temperature

(1) Current

The current of Bonto Marannu was measured from July 8th to 11th at one station located about 3.3 km WNW-ward from the cable landing point.

The measurement was done about 3 days continuously with interval of every 10 min. The results of the current observation are shown on Fig. 2-11.

Results of Current Observation at Bonto Marannu (Depth: 15.1 m)

	Dominant Directions		Velocity		Vector Mean*	
	N'ly(NW-N)	S'ly(S-SE)	max.	mean	Direction	Velocity
3 m under surface	30.2%	49.8%	37.6cm/s	18.9cm/s	163.1	4.7cm/s
1 m above seabed	20.5%	50.0%	25.9cm/s	13.4cm/s	145.7	4.1cm/s

The current variation in time series during the 3 days of continuous observation was shown on the current velocity curve (Fig. 2-12). According to the above listed table and Fig. 2-11 and 2-12, the appeared frequencies of the currents at surface and bottom layer are concentrated in northern and southern direction. The velocity curve (Fig. 2-12) shows that dominant directions turn round regularly in southern and northern with effecting the semidiurnal tide.

It has been reported that there are the southern going current and the current goes to Jawa sea through the Makassar Strait during a year. However, as far as the results of survey at this time shows, that the current along the coast of Bonto Marannu is turned round in nothern and southern direction by the effect of tidal current.

The current velocities were max. 37.6 cm/s (0.7 knots) and mean 18.9 cm/s (0.4 knots) at near surface and were max. 25.9 cm/s (0.5 knots) and mean 13.4 cm/s (0.3 knots) at the bottom layer.

(2) Water Temperature

The water temperature measurements were carried out at six points in the Bonto Marannu inshore area from 08:30 to 10:54 on July 10th. The temperatures at the seasurface (0.5 m beneath seasurface) and seabed (1 m above seabed) were listed on the following table.

Water Temperature at Bonto Marannu
(Observed on July 10th, 1988)

Station No.	B-500	B-1000	B-2000	B-3000	B-4000	B-5000
0.5 m under surface (°C)	27.2	27.2	27.2	27.3	27.6	28.0
1 m above seabed (°C)	27.1	26.9	26.6	26.7	26.6	26.6
Depth (m)	5.4	7.9	16.2	15.6	17.2	19.3

According to the above table, it can be seen that the surface temperatures at every station were between 27.2 and 28.0°C, but the value at near shore were lower than that of offing.

The range of water temperature at bottom layer was between 26.6 and 27.1°C but the value at near shore was higher than that of the station near offing. And the temperature of bottom layer became lower as increasing water depth.

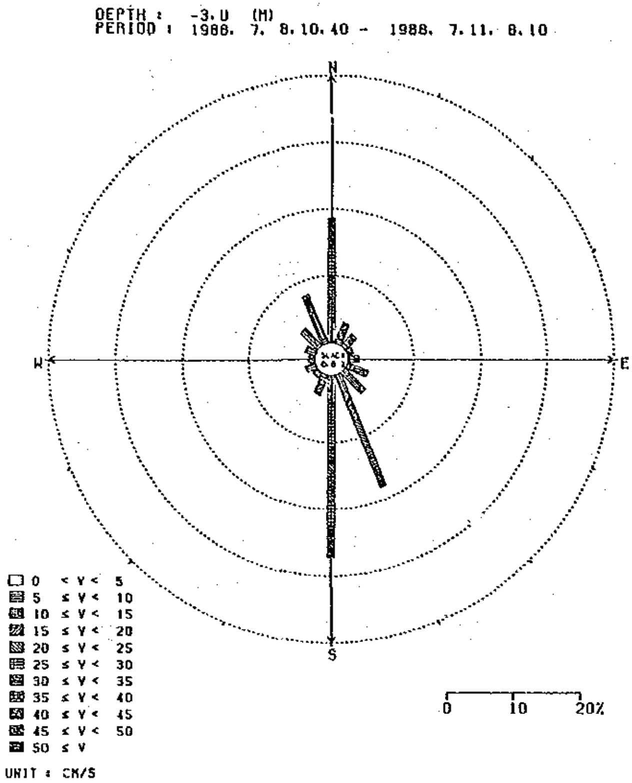
According to the water temperature variation in vertical section (Fig. 2-14), it was few variation at near surface layer of to 3 m under the surface. However, the variation of layers of deeper than 3 m was comparatively large. The water temperature variations in time series are shown on Fig. 2-13.

The statistical value of temperature in max, min, and mean obtained from the Marsden Square Data which was divided every 1° in the longitude and latitude were attached on Fig. 2-14. In comparison with the Marsden Square's values, the actual observed values were 0.2 to 0.9°C low.

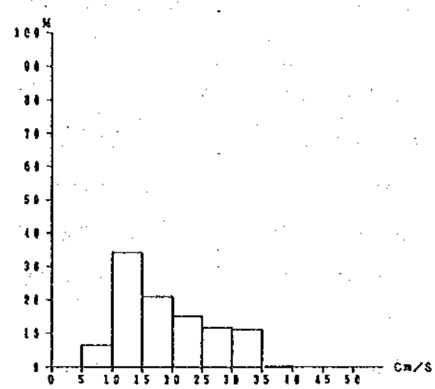
Examining Fig. 2-13, the features of variation are almost similar and difference of temperatures was small between upper and lower layer.

This discrepancy may be caused by the statistical value consisting of wide sea area, the effect of stream of river water and complicated currents near shore area.

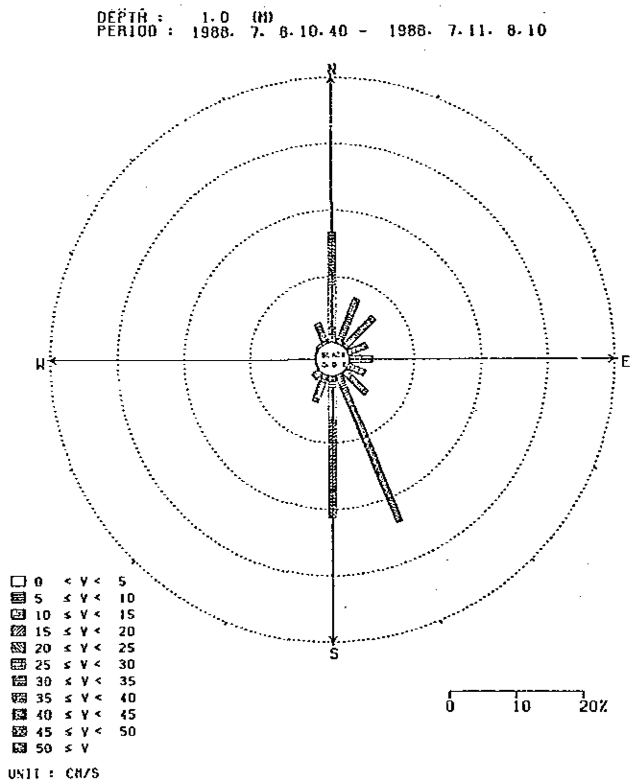
(Bonto Marannu)



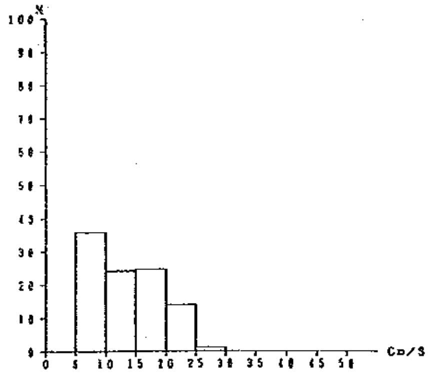
(Upper Layer)



Observation Layer: 3m Under Surface

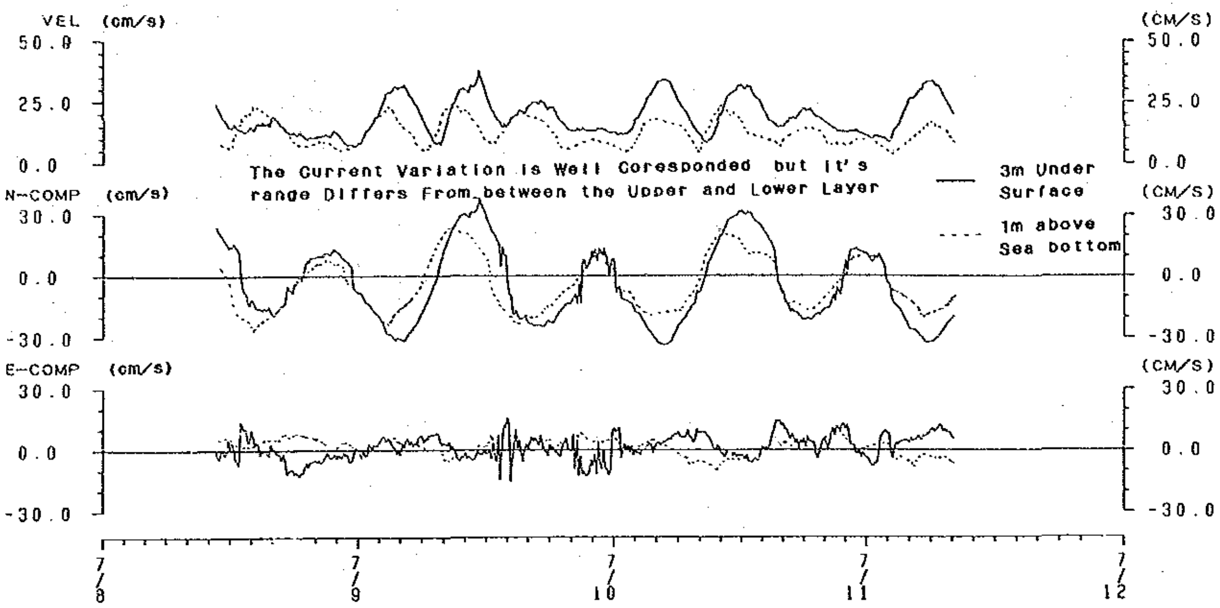


(Lower Layer)



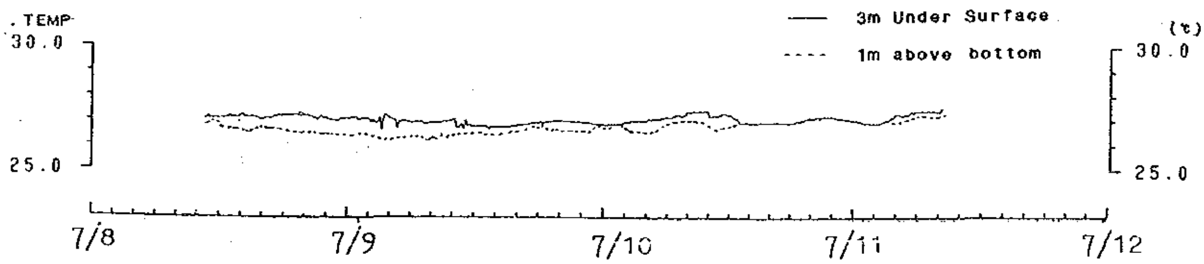
Observation Layer: 1m above Sea Bottom

Fig. 2-11 Current Velocity/Direction Frequency Distribution (Bonto Marannu)



Bonto Marannu

Fig. 2-12 Current Velocity Curve in Time Series



Bonto Marannu

(Figure Was drawn Basing Upon Data Obtained at Current Obs. Station)

Fig. 2-13 Water Temperature Variation in Time Series

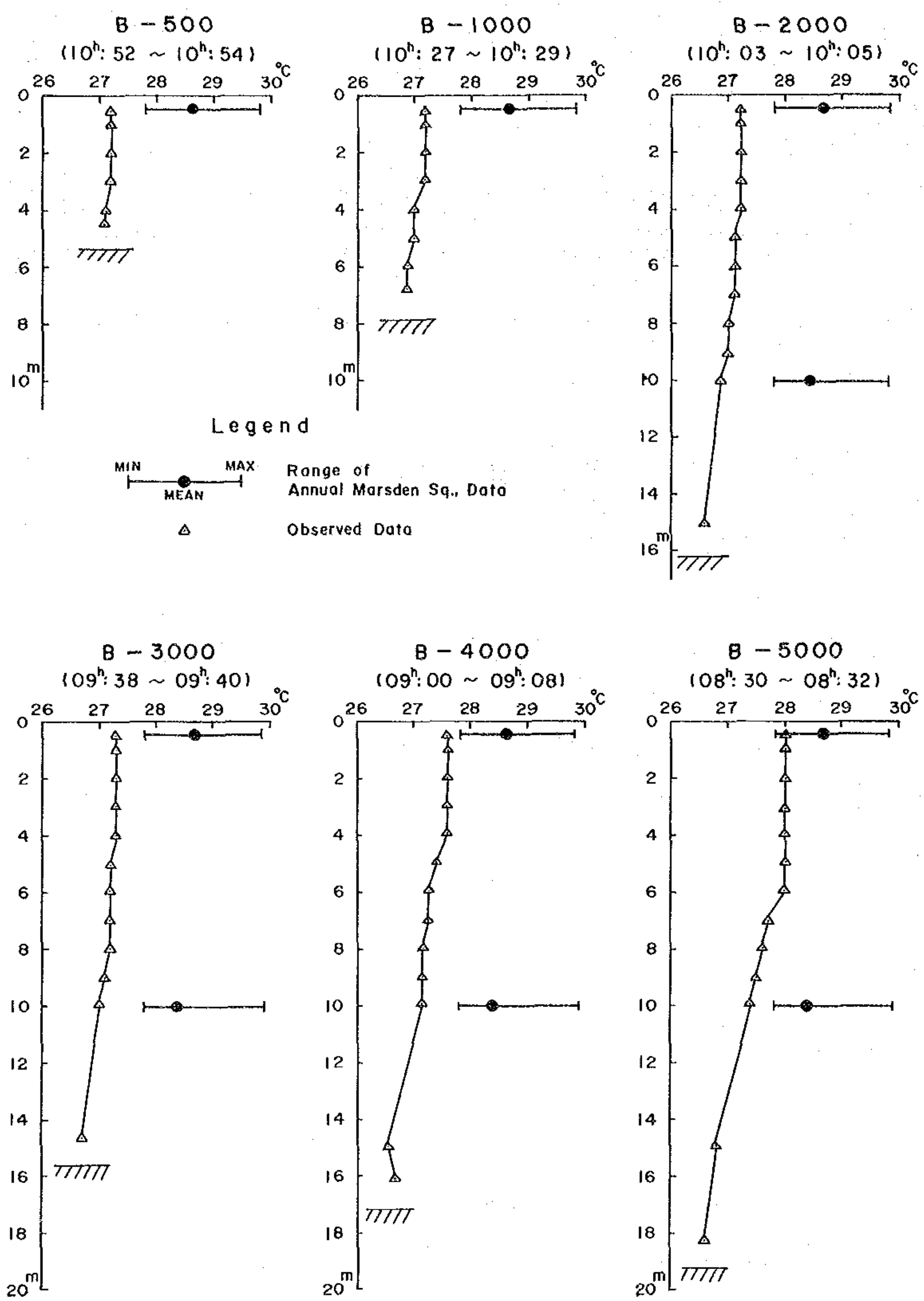


Fig. 2-14 Water Temperature at Bonto Marannu Inshore (July 10, 1988)

2.3.5 Mine Search

At the coast of Bonto Marannu cable landing site, the un-swept mine area is spreading out up to 22 km off from the beach.

The selected cable route to approach the cable landing Site is crossing this mine area, as shown on Fig. 1-5. Therefore in order to keep the safety of the survey vessels and survey instruments, the spot mine search was carried out in advance of ship's anchoring and survey works.

In Japan, the magnetic mine search utilizing the reaction of iron (body of mine) against a magnetism, is carried out in the un-swept mine area. And this mine search method has produced fine result on the mine detection.

On the survey, the spot magnetic mine search was done in the following manner.

(1) Setting a small buoy at the center of survey point.

(2) Divers who keep the magnetometer dive down to the sea bottom.

(3) Divers walk on the seabottom with the magnetometer at the circular area of 10 m from the center.

(4) Onboard measurement instrument which is connected with the magnetometer through the cable, detects the variation of the sea bottom magnetic field.

The total of nine times mine search were done at the mine area off Bonto Marannu landing point, but no magnetic anomaly was found. Accordingly, no changing was made on the selected survey points.

2.3.6 Earth Resistivity Measurement

The earth resistivity measurement was made at the Bonto Marannu landing Site to locate the most suitable low earth resistivity line near the beach for constructing an ocean ground.

The three lines, EP-1, EP-2, and EP-3, were set up near the cable landing point as indicated on Fig. 2-15. The measurement was done by the Wenner's Four-Electrode method along the said three lines and the obtained earth resistivity at each line are shown on Fig. 2-15 and Table 2-8 respectively.

Table 2-8 Earth Resistivity

Line	EP-1		EP-2		EP-3	
a	R	2 Ra	R	2 Ra	R	2 Ra
0.5 m	4.2x10	263.76	10.7x10	671.96	3.3x0.1	2.072
1.0 m	4.6x1.0	28.89	25.1x1	157.63	13.4x0.01	0.842
1.5 m	13.8x0.1	8.67	7.2x1	45.216	11.6x0.01	0.728
2 m	6.8x0.1	4.27	20.5x0.1	12.874	8.2x0.01	0.515
3 m	3.5x0.1	2.198	5.7x0.1	3.580	5.1x0.01	0.320
4 m	15.5x0.01	0.9734	3.8x0.1	2.368	---	---
5 m	13.5x0.01	0.8478	3.25x0.1	2.041	3.0x0.01	0.188
10 m	6.0x0.01	0.3768	21.0x0.01	1.319	1.1x0.01	0.069
15 m	---	---	19.2x0.01	1.206	---	---

The earth resistivity of each line is quite low, therefore, it will be easy to construct an ideal ocean ground which has ground resistance value of less than one ohm, along any lines. However, as the EP-3 line is too close the surf area, it is recommended that the ocean ground shall be constructed along the EP-1 or EP-2 to reduce the cost. The required electrodes will be less than six with buried depth of more than 5 meters.

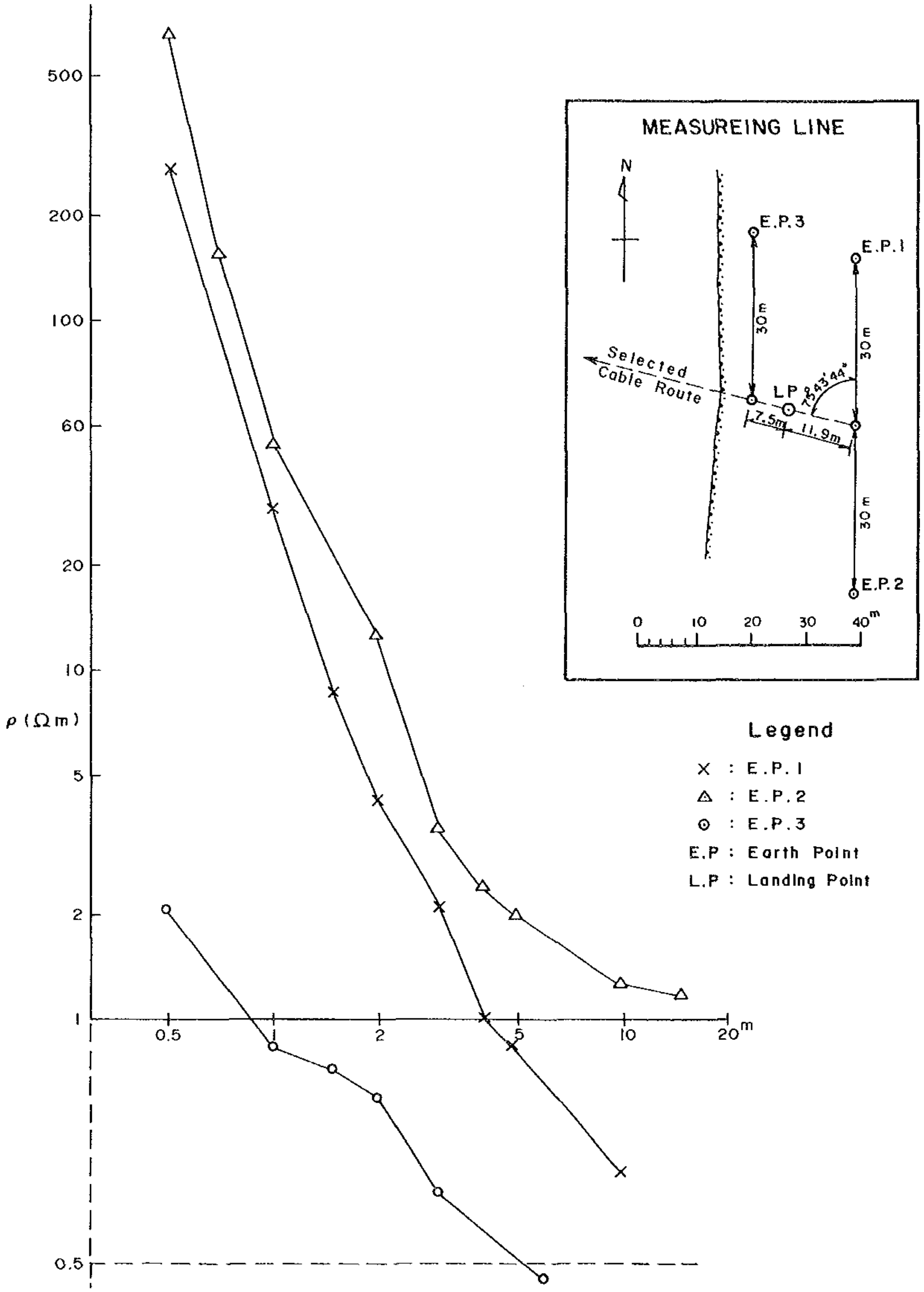


Fig. 2-15 Earth Resistivity Measurement at Bonto Marannu

CHAPTER 3 OFFSHORE SURVEY

CHAPTER 3 OFFSHORE SURVEY

3.1 General

The planned cable route amounts to 663 kilometers connecting Takisung (Kalimantan) with Bonto Marannu (Sulawesi) via Tanjung Selatan, the NE portion of Jawa Sea, Makassar Strait and Sulawesi Shelf. This route was set up by the Phase-I Study Team of JICA after in-depth study by existing nautical charts, topographical and geological documents, offshore oil activities and mine area record, etc. The route was decided finally by the discussion with the Government of the Republic of Indonesia (POSTEL, PERUMTEL). The purpose of Phase-II Study is to confirm the suitability of planned cable route for the cable laying, burying and repairing and to collect the information required for the construction. The offshore survey was carried out on the two runs, they are the going run (from Takisung to Bonto Marannu) and the return run (from Bonto Marannu to Takisung). On the going run, the survey vessel sailed along the planned cable route with examining the seabed profiling, seabed scanning and sub-bottom profiling. On the return run, the survey vessel navigated two n.m. apart from the southward of the planned route with examining the seabed profile. The bottom sampling and measurements of current and temperature at the specific points were also conducted on the return run.

Furthermore, in order to obtain the better route, the supplementary surveys were also carried out so many times at the margin where the Jawa and Sulawesi Shelf descend to the South Makassar Basin. The survey items and objectives are shown on Table 3-1.

Table 3-1 (1/2) Survey Items and Objectives

Item	Objective
Seabed Profiling	* To clarify the seabed topography along the cable route for cable laying and burying * To obtain the seabed profile * To clarify the topography around the cable route
Seabed Scanning	* To confirm the presence of obstacles, e.g. rocks, sunken ships, etc. * To clarify the micro-topography and seabed material
Sub-Bottom Profiling	* To clarify the geological structure in the upper part under seabed * To clarify the hazardous outcropped areas for the cable security after due consideration of seabed scanning results * To confirm the possibility of cable burying * To obtain the sub-bottom profile along the cable route
Bottom Sampling	* To clarify the nature of bottom material by visual observation, physical test and chemical test * To compare and confirm the data obtained by the seabed scanning and sub bottom profiling
Seabed Photographing	* To observe directly seabed condition on the cable route * To compare the seabed conditions with information obtained by scanning and sounding

Table 3-1 (2/2) Survey Items and Objectives

Item	Objective
Water Temperature Observation	* To obtain the necessary data for making the design of cable system
Current Observation	* To predict the current conditions at the time of cable laying and the annual current conditions based on data from observation and available existing data
Cable Burying Survey	* To investigate the suitability of cable burying * To obtain data for burying depth and tension at the time of cable laying and burying
Mine Search	* To confirm the existence of mine for the safety of survey works

3.2 Outline of Survey

At the offshore portion along the route, the survey was conducted on the items as shown in Table 3-2.

The detailed survey instruments and means are described on the Appendix 3.

Table 3-2 Outline of Survey

Survey Item	Instrument	Survey Area
Positioning	GPS, NNSS, OMEGA, Radar	Whole offshore area
Seabed Profiling	Echo Sounder for shallow sea Echo Sounder for deep sea	Area shallower than 100 m in depth Area deeper than 100 m in depth
Seabed Scanning	Side Scan Sonar	Area shallower than 200 m in depth
Sub-bottom Profiling	Sub-Bottom Profiler for shallow sea Sub-Bottom Profiler for deep sea	Area shallower than 100 m in depth Area deeper than 100 m depth
Bottom Sampling	Piston Corer Vibro Corer Dredger	10 points in area of muddy sediments 8 points in area shallower than 50 m 1 point in out-cropped rock area
Seabed Photographing	Deep Sea Camera	8 points in offshore area 15 m to 1300 m in depth
Current Observation	Current Auto Recording meter	5 points in offshore 30 m to 1900 m in depth
Water Temperature Observation	Electric Thermometer and Current Auto Recording meter (attached thermo-sensor)	5 points in offshore 30 m to 1900 m in depth
Mine Search	Magnetic Prospector	1 point at 10 km off Bonto Marannu
Cable Burying	Cable Burier (1/2 scale)	Section 10 nm in Jawa Shelf

3.3 Submarine Topography

The survey area in the offshore portion along the selected route can be clasified into the following three areas from a topographic point of view:

(1) Jawa Shelf (a part of Sunda Shelf)

(2) South Makassar Basin

(3) Sulawesi Shelf

These areas are shown in Fig. 3-1 together with the seabed profile.

The data obtained by the survey were immediately analyzed on board the ship to examine the suitability of the cable route.

In the section where the condition was found to be unsuitable for cable route, the supplementary survey was fully carried out during the return run survey (refer to Fig. 3-3 and 3-5).

Some part of the planned route was altered based on the results of the survey as follows (refer to Fig. S-1).

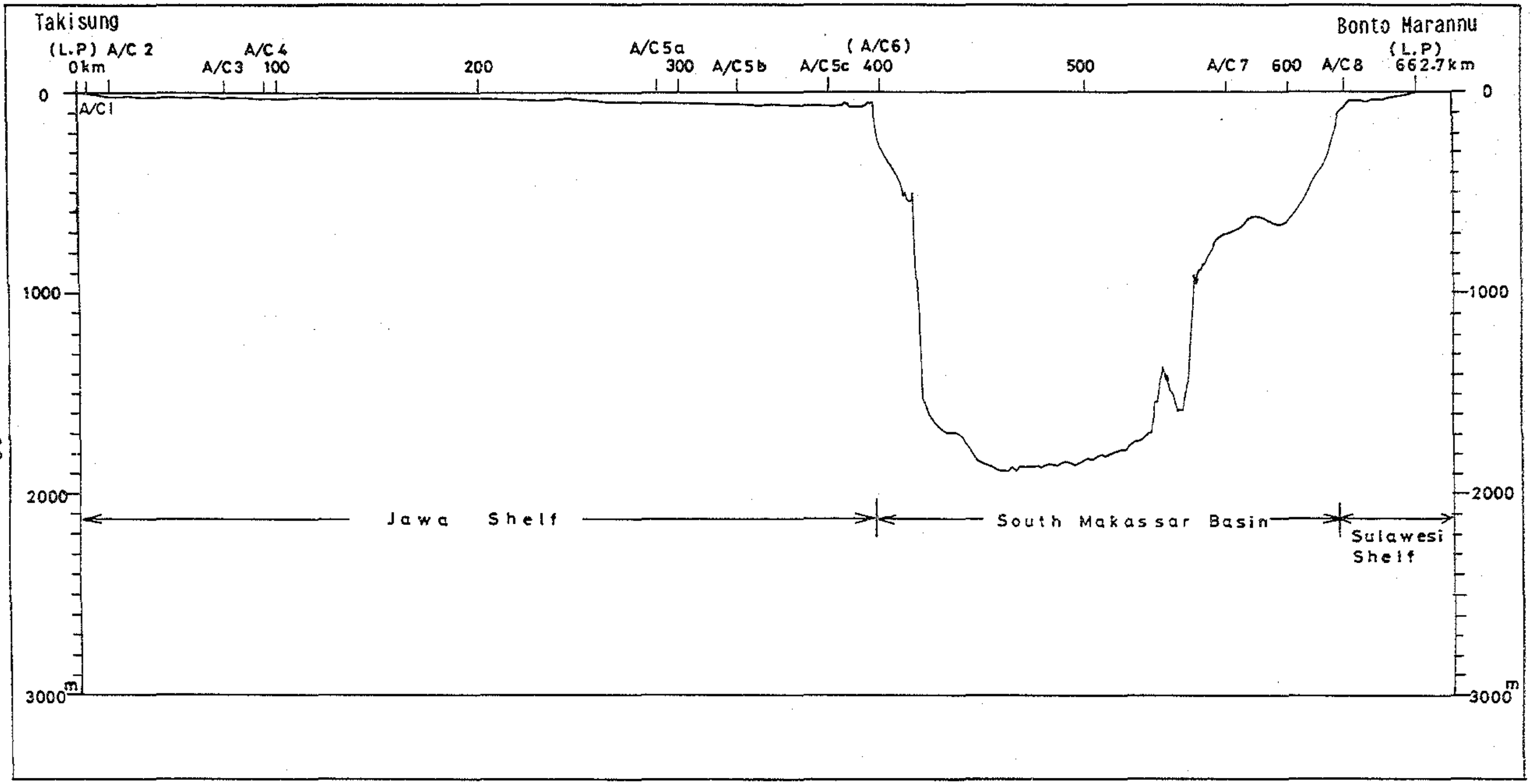


Fig. 3-1 Seabed Profile Along the Selected Cable Route

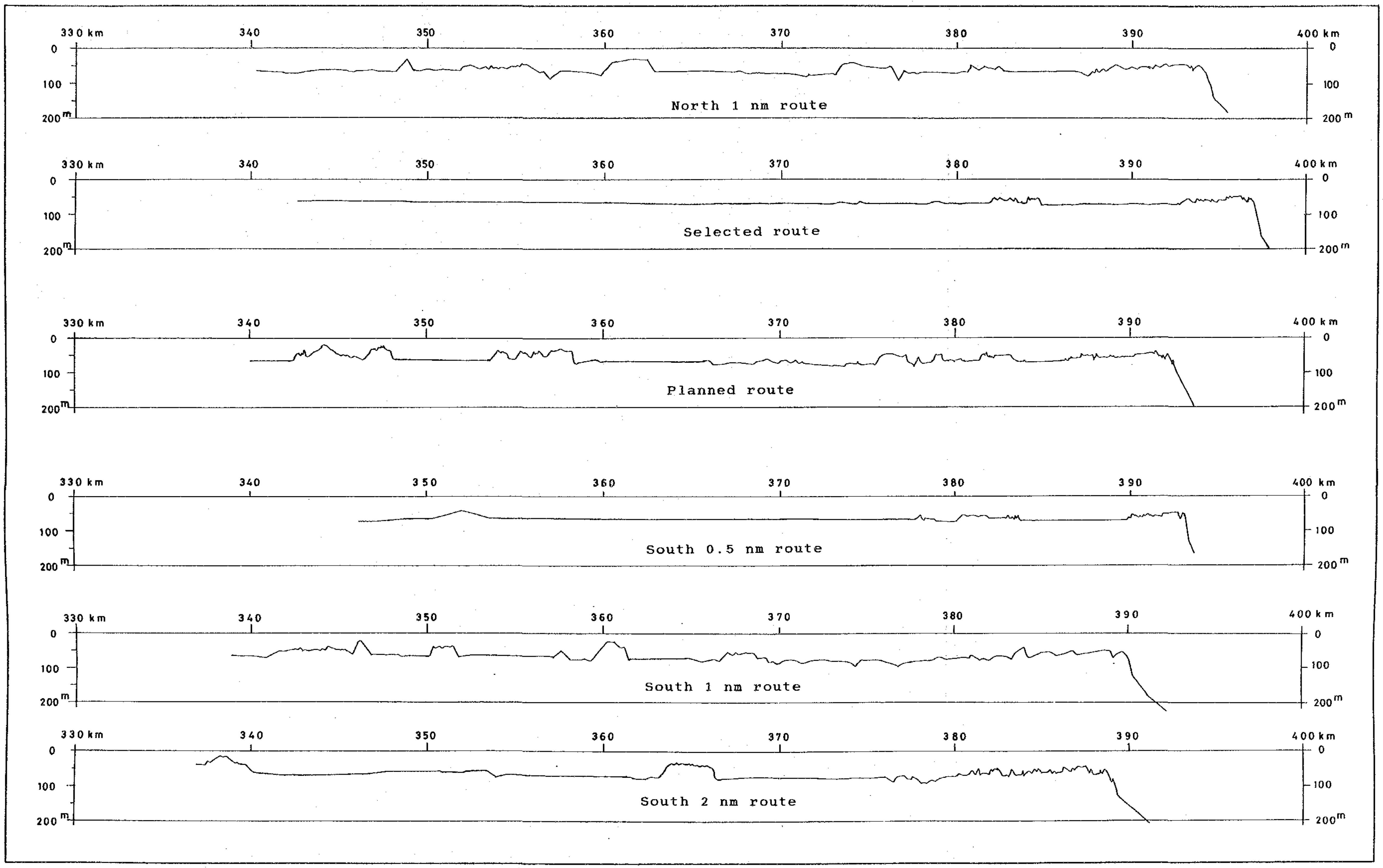
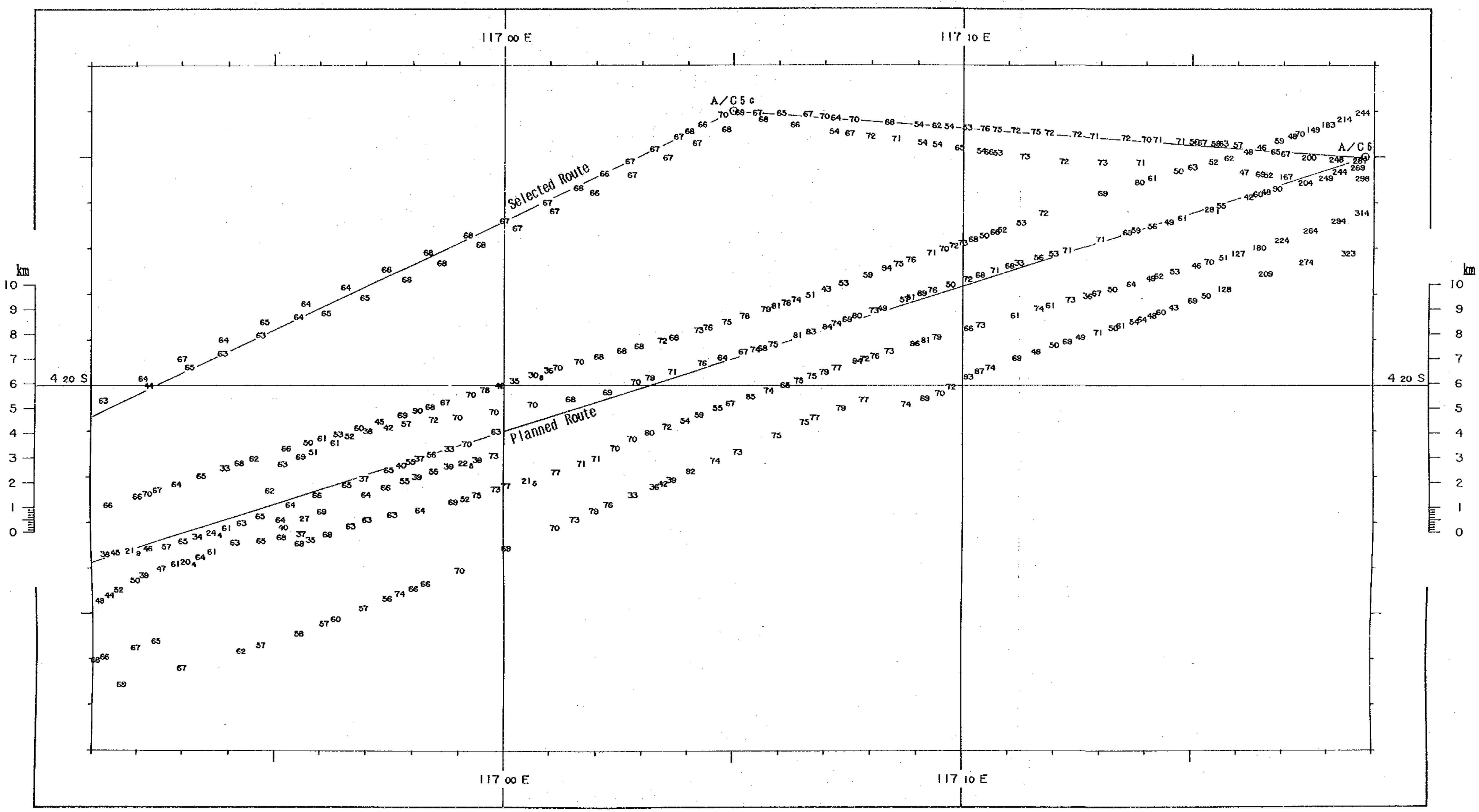


Fig. 3-2 Profiles Around A/C 6

1/150000 (Lat. 5° S WGS-72)



Mercator's Projection

Fig. 3-3 Bathymetric Chart Around A/C 6

The relation of altered course points (A/C) between Phase-I and the Phase-II Study is shown in the following table.

Phase-I A/C Point	Phase-II A/C Point
T.L.P	T.L.P (New established Point)
	A/C 1 (New established Point)
A/C 1	A/C 2 (Same as A/C 1 on Phase-I)
A/C 2	A/C 3 (Same as A/C 2 on Phase-I)
A/C 3	A/C 4 (Same as A/C 3 on Phase-I)
A/C 4	————————
	A/C 5a (New established Point)
	A/C 5b (New established Point)
	A/C 5c (New established Point)
A/C 5	A/C 6 (Same as A/C 5 on Phase-I)
A/C 6	A/C 7 (Same as A/C 6 on Phase-I)
	A/C 8 (New established Point)
A/C 7	
A/C 8	B.L.P

Remarks: T.L.P = Takisung Landing Point
B.L.P = Bonto Marannu Landing Point

(1) Between T.L.P and A/C 1 (on Phase-I)

The L.P which had already been decided on the Phase-I Study, being common with the established L.P for the cable route between Surabaya and Banjarmasin, was newly shifted southward about 160 m.

As the results of the inshore survey, it became clear that outcropped rocks extending from south to north at about 1.5 km offing of T.L.P had an effect to the planned cable route. Therefore, the route was altered to north a little to avoid them and new A/C 1 was established at about 5 km off T.L.P. After then, the new A/C 1 was joined to A/C 1 (Phase-I) and A/C 1 (Phase-I) was newly named as A/C 2 (Phase-II). Following A/C Nos. were sequently moved down in order.

(2) Between A/C 5 (on phase-I) and A/C 6 (on Phase-II)

The coral reefs are distributed widely in this section. As the results of the supplementary survey, it was confirmed that there were many undulations with large relative heights and steep slopes. Therefore, the planned route was altered to pass the northward area with the comparative small undulations. Accordingly the A/C 4 (Phase-I) was shifted to about 7.5 km eastward and was named as A/C 5a. Furthermore, two A/C points of A/C 5b, A/C 5c were placed additionally on the route. The route was joined from A/C 5c to A/C 5 (Phase-I). The seabed profiles along the supplementary survey lines are shown on Fig. 3-2.

(3) Between A/C 6 (Phase-1) and B.L.P

The exposed coral reefs with large relative heights and steep slopes exists adjacent area about 10 km westward of A/C 7 (Phase-I).

Therefore, in order to avoid these coral reef area, the route was altered to southern area with smaller undulations. Accordingly, A/C 7 (Phase-I) was shifted to westward about 13.4 km on the line connecting A/C 7 (Phase-I) with B.L.P. The seabed profiles along the supplementary survey lines are shown on Fig. 3-4.

The condition of bottom profiles and sub-bottom profiles along the selected route are described hereto with three divided sea areas. Furthermore, each of the sea areas is divided by the difference of seabed topography and gradient, the characteristics of undulation, etc.

The distance used in the following description were cumulated from the Takisung Landing Point (T.L.P).

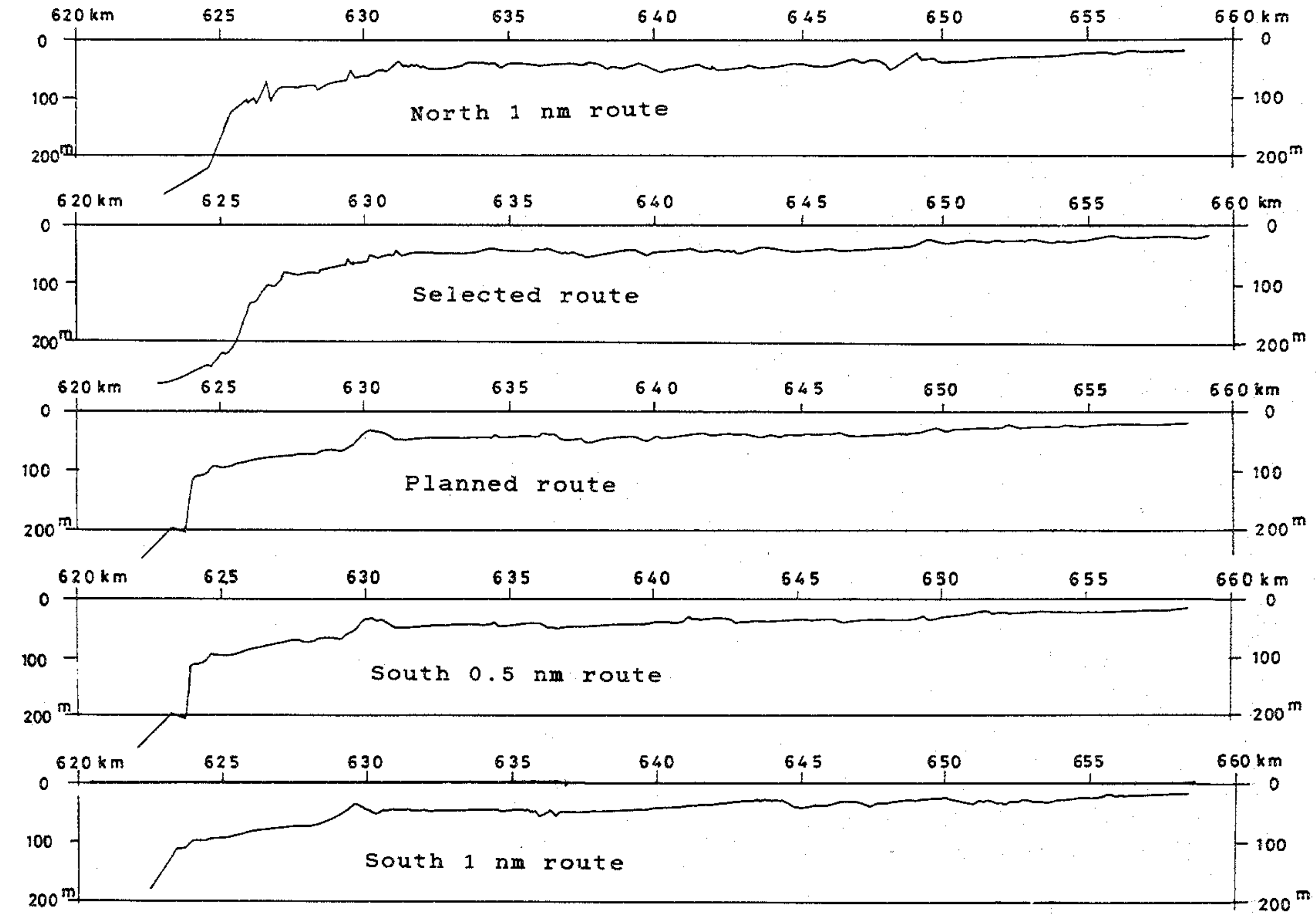
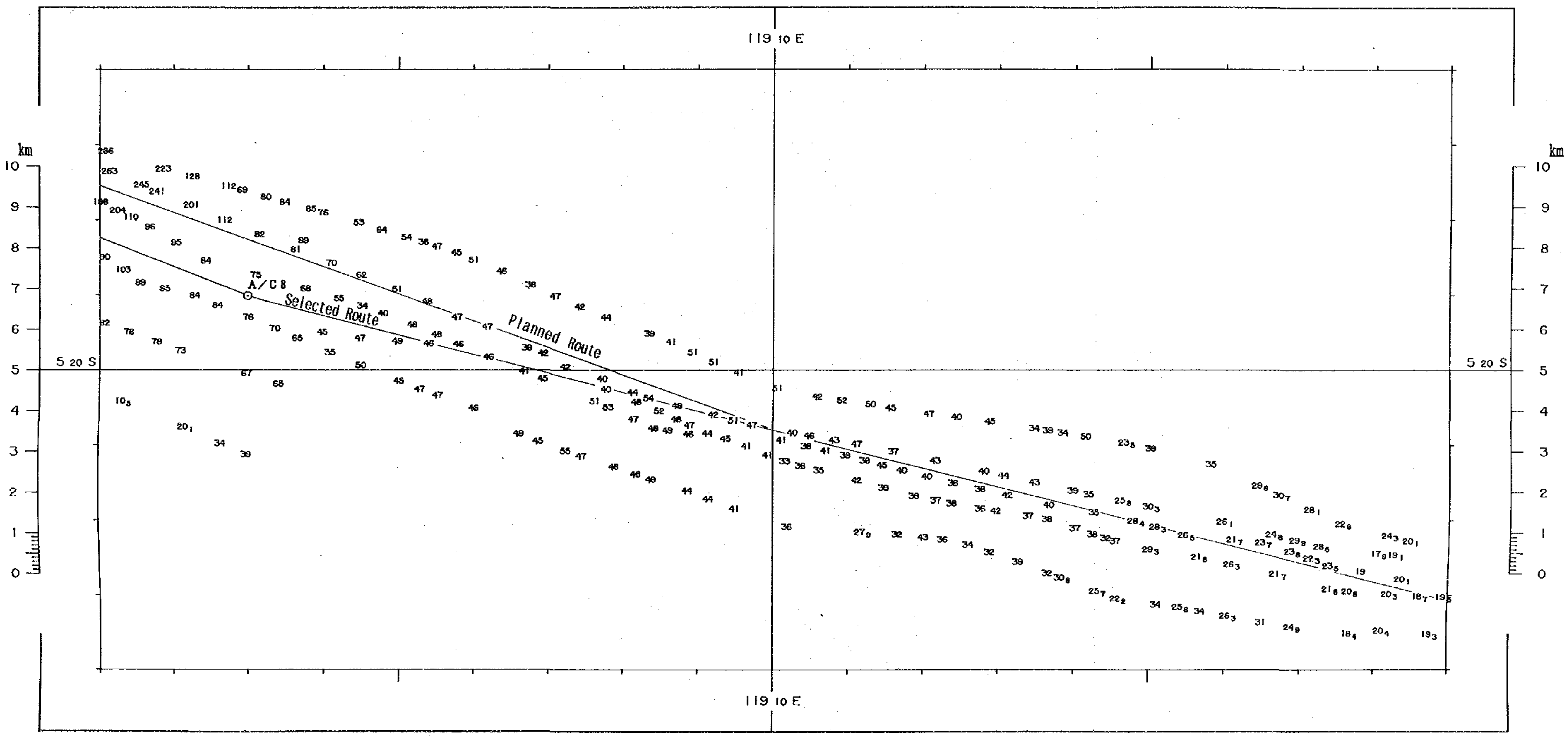


Fig. 3-4 Profiles Around A/C 8

1/100000 (Lat. 5° S WGS-72)



Mercator's Projection

Fig. 3-5 Bathymetric Chart Around A/C 8

3.3.1 Jawa Shelf

The characteristics of submarine topography in the Jawa Shelf along the selected cable route are summarized as follows (refer to Fig. 3-1):

(1) The section from 5 km to 13 km

The seabed is quite smooth up to 12 km offing of Takisung. A gradient of the downward slope becomes gradually gentle from the beach (1/600) to offing. It reaches to a topographic break point at 13 km off Takisung.

(2) The section from 13 km to 200 km

1) The gradient of downward slope increases to 1/250 at the break point. Beyond the break point, the shallow sea area with mean depth of 25 m continues up to 200 km. Though the seabed is generally flat, several undulations appear in some places.

The characteristics of these undulations are shown in Table 3-3.

Examining the conditions of seabed surface in this section by the side scan sonar records, many small size dimples which could not be clearly distinguished by the echo sounder were recognized.

The portion with many small dimples and no existence of them were observed alternatively, with interval of 2 - 25 km, at the section of 104 - 154 km.

The width of each portion with the dimples is 3 km to 15 km approximately. Though the dimples size and shape slightly differ in each portion, the size of dimples is mostly in 5 m x 7 m to 8 m x 10 m.

Number of the dimples is 5-25/km² in these portions and the distribution of dimples is generally dispersion type. However, there are some places where small dimples of 3 m x 5 m concentrate within the area of 250 m x 250 m such as the portion between 24 km and 26 km.

Table 3-3 Characteristics of Undulation (13 km to 200 km)

Section (Distance (from T.L.P)	Height	Width	Gradient	Condition
15-38.5km	1.0-5.0m	2000-4000m	Less than 1° (1/57)	Undulations have a gentle slope with long wave-length
43.5-72km	(1) 1.0-1.5m (2) 15-25m	70-120m 300-400m	Less than 2° (1/30) Less than 2°	Two types ((1) & (2)) undulation are found but each slope is not so steep.
87-104km	(1) 1.5-2.0m (2) 2.0-4.0	130-150m 1000-1800m	1° - 2° Less than 1°	Two types ((1) & (2)) undulation are found but each slope is not so steep.
157-166km	1.0-2.5m *(1.6m)	150-200m *(40m)	Less than 2° (1/30) *(5°(1/12))	Undulation is relatively gentle except *one dimple with a steep gradient.
177.5-193km	(1) 1.0-2.5m (2) 2.5-5.0m	60-200m 1000-2000m	Max. 7°(1/8) Less than 1°	Most of small scale undulations are less than 2°. Undulation have a gentle slope with long wave-length.

2) Two depressions with relative heights of 7 m and 10 m can be seen around 40 km and 74 km. The former has about 4 km in width and 1/20 in maximum gradient of the slope, and the latter has about 3 km in width and 1/40 in maximum gradient of the slope.

   Along each of the slope, some small undulations are observed.

3) An upheaval with small relative height and gentle slope exists in the section between 104 km and 123.5 km.

4) Almost of the undulations which exists in this section, have slopes less than 2°, but some of small scale undulations have relatively steep slope with the gradient of 3° to 7°.

(3) The section from 200 km to 397 km

The seabed changes into a gentle downward slope with mean gradient of 1/800 around 200 km (28 m in depth) and reaches to the west end of South Makassar Basin. The sea depth at the margin of Jawa shelf is 70 m.

The submarine topography in this section is almost similar to the description of the section from 13 to 200 km.

The characteristics of seabed feature are summarized as follows:

1) The seabed between 200 km and 280 km, small scale undulations are observed. The width and height of these gradients are in the range of 60-450 m and less than 1/13 (4.5°) respectively. On the records

of side scan sonar, small size dimples are observed in almost all the part of seabed.

The size of the small one of them is 5 x 7 m and of the large one is 10 x 40 m. The number of dimples is 5-20/km^2 normally, but it can be seen that the small size dimples 3 m x 5 m concentrate within the area of 125 m x 75 m as in the section of 239.5 to 260 km.

2) The upheaval with relative height of 11 m (30 m in depth) exists between 239.5 km and 260 km. The upward slope and top are accompanied with small undulations of less than 2 m in height, but downward slope is smooth. The mean gradient of the upward slope is 1/375 and that of the downward slope becomes more gentle.

3) In the section from 280 km up to 372 km, the seabed generally continues in smooth and flat conditions.

However, some small scale undulations with relative height of 1.5 m to 3.0 m are found at the portion of 310 km and 342 km and the range of each portion is several km. On the record of side scan sonar, small size dimples are observed in almost sections excepting 308 to 317 km and 361 to 372 km.

Especially there are many dimples in the section from 317 km to 361 km. The number of dimples is counted as 50/km^2 and their size are almost 7 x 13 m to 7 x 20 m.

4) In the section from 372 km up to the eastern margin of Jawa Shelf (397 km), many coral reefs and shallows are distributed around the margin.

Especially, these conditions are remarkable at the southern part of the planned cable route, and the seabed topography shows the most complicated features throughout the whole cable route.

The water depth at the top of appeared coral reefs is 10 m to 25 m shallower than mean water depth. Many unevennesses appear continuously on the coral reef. The maximum gradient of the unevenness and maximum relative height of them are 1/4 (14°) and 10.5 m, respectively.

This section can be divided into two areas by the side scan sonar records. The first area from 372 km to 380 km and 385 km to 390 km is covered with a thin muddy sediment and the other area is covered with a outcrops of coral reef. In the first area, there are many dark spotted patterns on the side scan sonar records which shows the existence of rock near under the bottom surface.

5) The characteristics of undulations in the section from 200 km to 397 km are shown in Table 3-4.

Table 3-4 Characteristics of Undulation
(200 km to 397 km)

Section (Distance (from T.L.P)	Height	Width	Gradient	Condition
260-38.5km	1-3m	160-450m	Less than 3° Max. 4.5 (1/19)	Undulations show mainly depression type, and two undulations of them are distributed on the route at about 1 km interval
227-239km	3-4m	(1) 300-400m (2) 1300-1600m	Less than 1° (1/50)	Most of undulation have a long wave-length with gentle slope
260-279km	1-2m	60-150m	Max. 4° (1/14)	Most of declination of undulation are less than 3°
372-397km 1) 372-382km	2-7m	100-250m	Less than 3°	Small scale undulation exist in some places, but its declination is rather steep
2) 382-385km	4-10m	70-500m	3° - 8°(1.7)	Seafloor uniformly goes up to level of (-)53 m from level of (-)68 m. A number of undulations with steep slope exist on the coral reef.
3) 385-392.5km	1-3m	70-150m	1° - 4°(1/6)	Small scale undulation exist in some places.
4) 392.5-397km	(1) 1-3m	30-70m	5° - 10° (1/11)-(1/6)	Water depth on the coral reef is 46 m to 55 m shallower than 70 m in mean water depth.
(Max.	(2) 4-10.5m 13.5m	150-450m 130m	14° (1/4)	A many large scale undulations with steep slope continue for 4 km