STUDY REPORT
ON
THE SURABAYA-BANJARMASIN SUBMARINE CABLE PROJECT
IN
THE REPUBLIC OF INDONESIA

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AUGUST 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

STUDY REPORT
ON
THE SURABAYA-BANJARMASIN
SUBMARINE CABLE PROJECT
IN
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(VOLUME III)

— RESULT OF OCEAN SURVEY —

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SUMMARY

SUMMARY

The results of the ocean survey necessary the Surabaya-Banjarmasin Submarine Cable Project performed by the JICA Team are as follows:

1. Submarine Cable Route

The submarine cable route linking Bumi Anyar of the Madura Island with Takisung of Kalimantan Island has ben selected with economy and reliability in mind. (See Figure 1.)

The cable route extends 1.5 km north-northwest from the landing point (L.P) of Bumi Anyar, going about 7.2 km toward the North after passing through the bay. After that, the route runs north-northeast, going toward Takisung at a point approximately 7.2 km away. After extending over about 353.5 km, it reaches Takisung offing. Further, the route goes east-northeast from that point, reaching the Takisung landing point at about 19.3 km.

2. Sea Bottom Condition along Cable Route

At about 95 km from the cable landing point of Bumi Anyar along the route, it reaches the deepest section which is about 77 m deep. The sea bottom of Bumi Anyar side is covered with mud neartly on this section, and the submarine topography is very smooth. On the other hand, the sediments on Takisung side contains high percentage of sand, and undulations of submarine topography is increasingly greater.
The sea bottom is covered with soft sediments throughout the route, but here and there, sediments tend to be thinner on the Takisung side from the deepest section.

Judging from the sea bottom conditions mentioned above, there would be no obstacles to construct a submarine cable along this proposed cable route.

3. Non-swept Area for Mines at Bumi Anyar Coastal Area

The coastal area in front of the Bumi Anyar cable landing point is non-swept area for mines. So, the magnetic survey was conducted over a range, necessary for cable installation. A magnetic anomaly was measured at three points. One of them is at 60 to 80 cm below the sea bottom, and the gauss measured is relatively large (26 gauss.cm^2). When this value is studied based on the standard of Japan, it indicates that there are gauss.cm^2 of about 25 to 300 which correspond to a mine. It is considered necessary to confirm what the cause of this anomaly is, prior to the commencement of cable laying work.

4. Cable Length and Cable Type

The route length is 381.47 km between both landing points. As the cable is used to the extend of 500 m at the land part of both landing points with the average cable slack of 1.5%, the overall cable length will be 387.2 km. The following cable configuration is proposed for this cable route.

(1) Land sections are every 500 m, which comes to 1 km in total. It is recommended that the single armoured cable is directly buried for this section. When crossing the road half-way, it is necessary to install a piping under the road for protection with it passed through the piping.

(2) At an extremely shallow water section up to 10 m deep, it is recommended to use and bury the double armoured cable. Its length will be 4 km at Bumi Anyar, and 7 km at Takisung. But at the non-swept and swept area for mines on the coastal area of Bumi Anyar, it is desirable to bury the cable based on the non-burying technique or the jet burying technique.

(3) The shallow water area with water depth in excess of 10 m, it is recommended to use and bury the single armoured cable based on the cable burying technique.

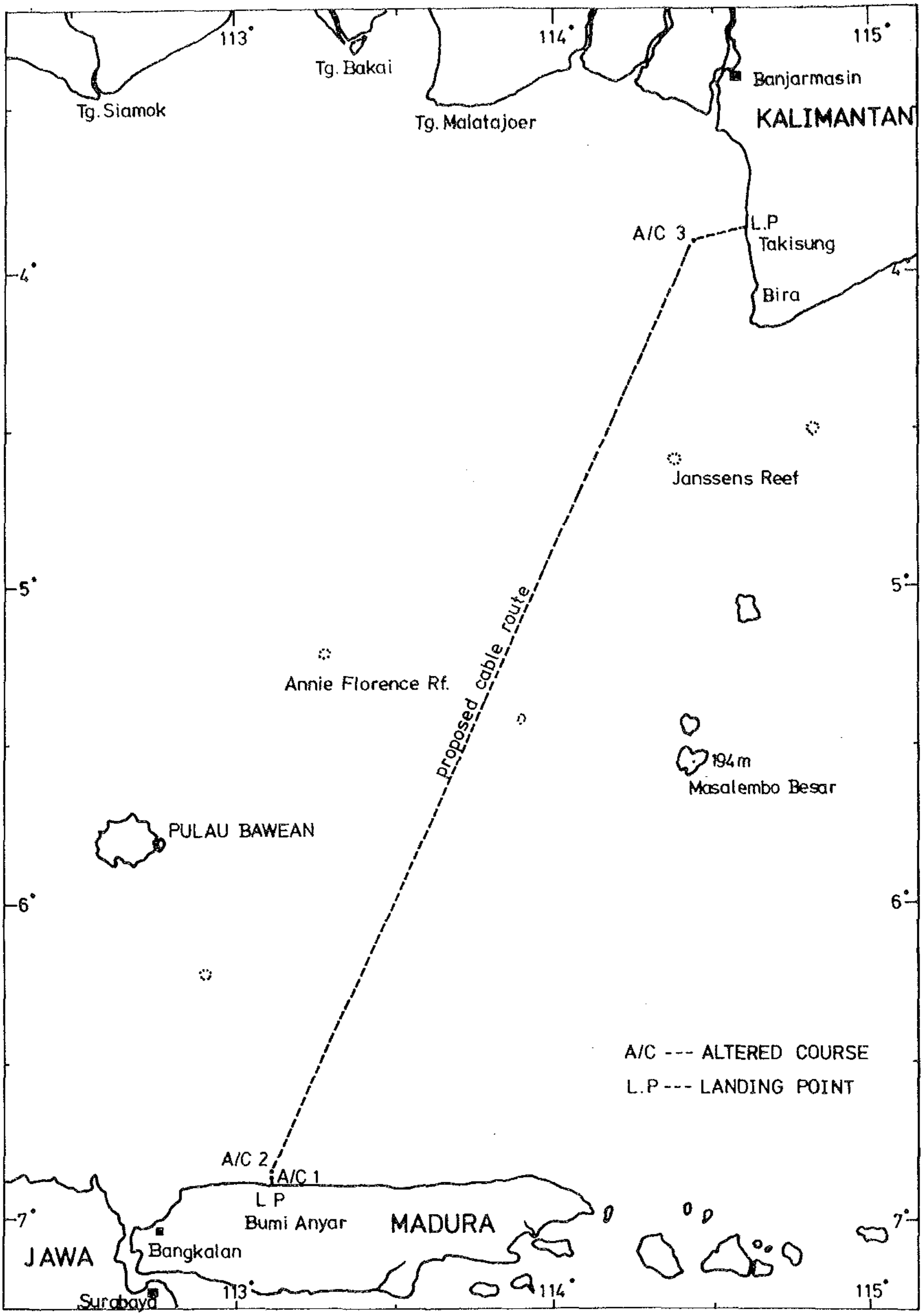


Figure I PROPOSED CABLE ROUTE

CHARTER 1 DESK-TOP STUDY

CHAPTER 1 DESK-TOP STUDY

1-1 General

This chapter contains data hitherto available in Japan, information and data collected in Indonesia, and that obtained through the Ocean Survey.

The major information and data utilized throughout this chapter are as follows:

* Ben-Avraham, Zvi, and Emery, K.O., 1973, *Structural framework of* Sunda shelf: AM. Assoc. Petroleum Geologists Bull., V.57, P.2323-2366.

* Emery, K.O. et al., 1972, Geological structure and some water characteristics of the Java Sea and adjacent continental shelf: U.N. ECAFE, C.C.O.P., Tech. Bull. 6,P.197-223.

* Katili, J.A., 1975, Geological environment of the Indonesian mineral deposits, a plate tectonic approach: U.N. ESCAP, C.C.O.P., Tech. Bull. 9, P.39-56.

* Hamilton, W., 1979, Tectonics of the Indonesian region: U.S. Geological Survey, Geological Survey Professional Paper 1078.

* Hydrographic Department of Ministry of Defence, U.K., 1983, Indonesia Pilot, V.2.

* Defence Mapping Agency, U.S.A., Sailing Direction.

* Petroconsultants, s.a., Aug. 1985, Petroleum Activity, Indonesia: Foreign Scouting Service.

* Nautical charts Relating to Cable Route Survey in the Survey Area.

1-2 Submarine Topography and Geology Adjacent Cable Route

First, the whole of the Jawa Sea where the submarine cable is planned to construct is described below.

The Jawa Sea is surrounded on the north by Bangka Island, Belitung Island and Kalimantan Island, on the south by Jawa Island and Madura Island, on the west by Sumatra Island, and also on the east by the deep sea which extends from Makassar Strait (Figure 1-2-1). The whole of the Jawa Sea belongs to the so-clled continental shelf, and here the water depth is less than 100 m. Several islands are scattered in the Jawa Sea. The representative islands from the west to the east are Kep. Karimunjawa, P. Bawean, P. Madura, P. Kangean and etc.. The seafloor is extremely flat except near the eastern edge of the Jawa Sea and the islands mentioned above. The area water depth 40-80 m covers more than 50% of the Jawa Sea. The deepest area with water depth 80-100 m is located in the middle between P. Bawean and P. Kangean.

Near Jawa Is. and Madura Is. the seafloor has a gradient of about 1/300 from the shore line to the area water depth 40 m, but it has a quite gentle slope near Sumatra Is. and Kalimantan Is. It is conside-rable that the topography on the land extends in the sea. In the shore area of Sumatra Is. and Kalimantan Is. facing the Jawa Sea, many broad deltas have grown.

The basements of the Jawa Sea underlain the sediments and sedimentary rocks are low-grade metasedimentary rocks and granitic rocks based on the data of oil-exploration wells (W. Hamilton, 1979). These base-ments indicate Cretaceous and Paleocene age according to many K-Ar age determinations. The thickness of Cenozoic sediments and sedimentary rocks above the basements reaches more than 3,000 m in the several basins of the Jawa Sea (W. Hamilton, 1978). These sedimentary basins are called Sunda Basin, Billiton Basin and Bawean Trough from the west to the east (Figure 1-2-2).

The uppermost sediments which belong to pleistocene age have complicated structures, namely "Cut-and-Fill Features" (K. O. Emery et. al., 1972). Those structures were formed by the erosion and sedimentation caused by the glacial eustasy during Pleistocene age. It is famous that the Paleo-River System is hidden under the sea in the Sunda Shelf and the Jawa Sea. Figure 1-2-1 roughly indicates this Paleo-River system, which was prepared by K. O. Emery et. al. (1972) based on the maps of Molengraaff (1921) and Kunen (1950).

The main bottom sediments in the Jawa Sea are Mud, Sandy Mud and Muddy Sand. This is illustrated in Figure 1-2-1 (K. O. Emery, 1972). Sand, Gravel, Rock and Coral are distributed only in the neighborhood of islands. Relatively broad areas of Sand exist off South-eastern Kalimantan.

The area along the proposed cable route is described hereinafter based on the existing data.

The seafloor near the shore in Bumi Anyar, Madura Island has a gradient of about 1/300 according to the nautical charts as described above upto the area water depth 40 m, which is located about 15 km away from the shore line. From the area water depth 45 m (about 18 km away from the shore line), the seafloor tends to become flat. The area of maximum water depth is located about 90 - 95 km away from Madura shore line, and the depth is about 75 m. From the area of maximum water depth to the Takisung offshore, the seafloor has a gentle slope with gradual undulations, the gradient of which is about 1/4,500 on an average. Many fairways can be traced offshore Takisung until the area water depth about 20 m from the revers on land. The direction of those fairways is almost north to south. The sidewalls of fairways have relatively steep slopes. For example, the gradient of the sidewall along the proposed route is about 1/350.

The data and information for submarine geology along the proposed route are limited. However the next conditions can be mentioned based on the submarine topography described above, the nautical charts, etc. The outcrop of old-type reef limestone was recognized on the shore in

Bumi Anyar during the reconnaissance for the landing point. Therefore there is a possibility that the old-type reef limestone exists also in the sea area near the shore of Bumi Anyar. Sandy Mud is distributed 15 km away from the shore line in Bumi Anyar. Mud consists of main bottom sediments from the area 35 km away from the shore line in Bumi Anyar to the deepest area. From the deepest area to the area offshore Takisung, the bottom sediments are Sand, Mud, and Sandy Mud. It seems that those variable bottom sediments have close relationship with the characteristic topography mentioned above. In the area offshore Takisung, Coral, Stone and Sand are distributed. The outcrop of low-grade metasedimentary rocks were recognized on the shore in Takisung during the reconnaissance for the landing point. Therefore, there is a possibility that the same rocks exist also in the sea area near the shore of Takisung.

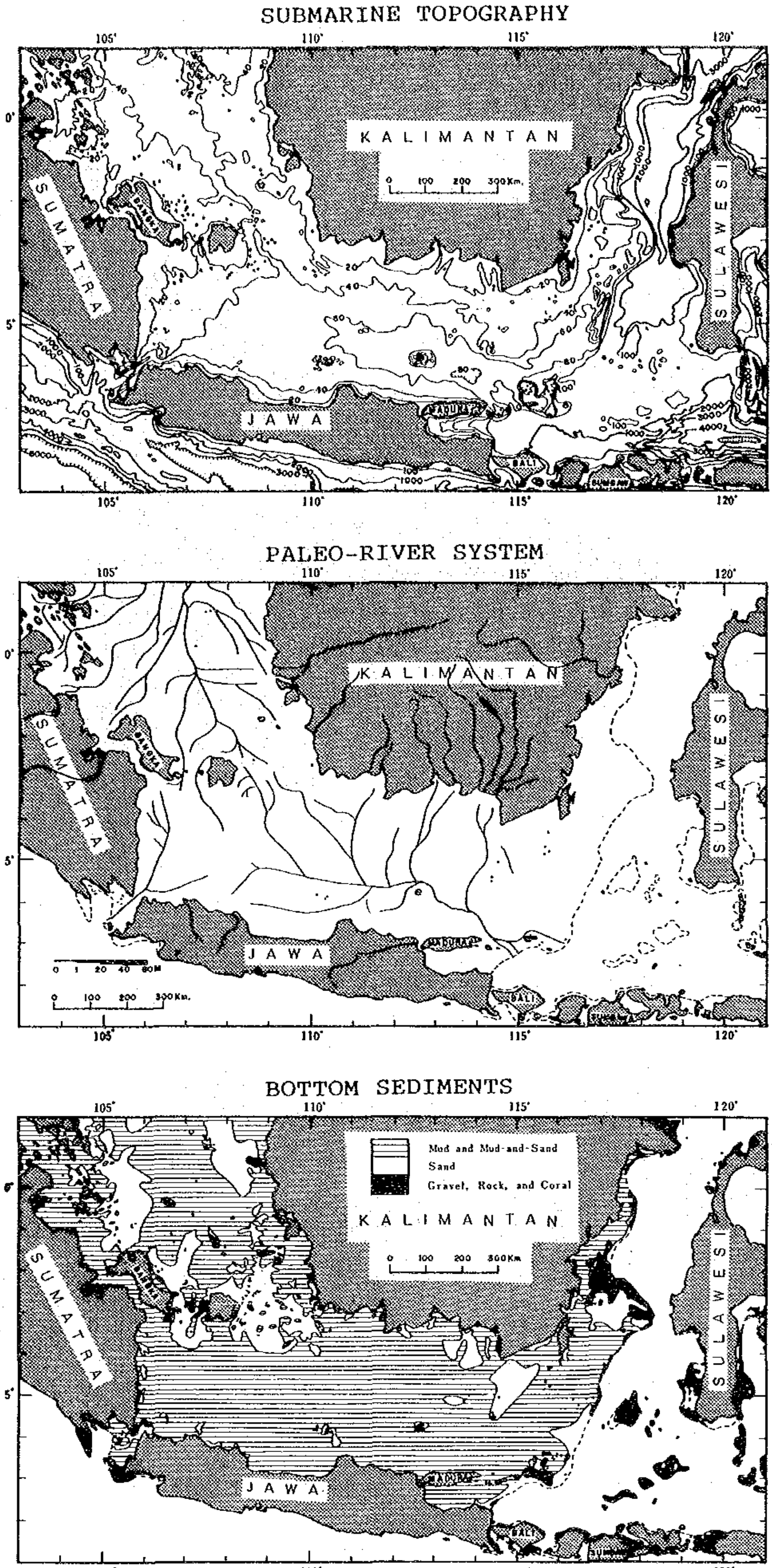
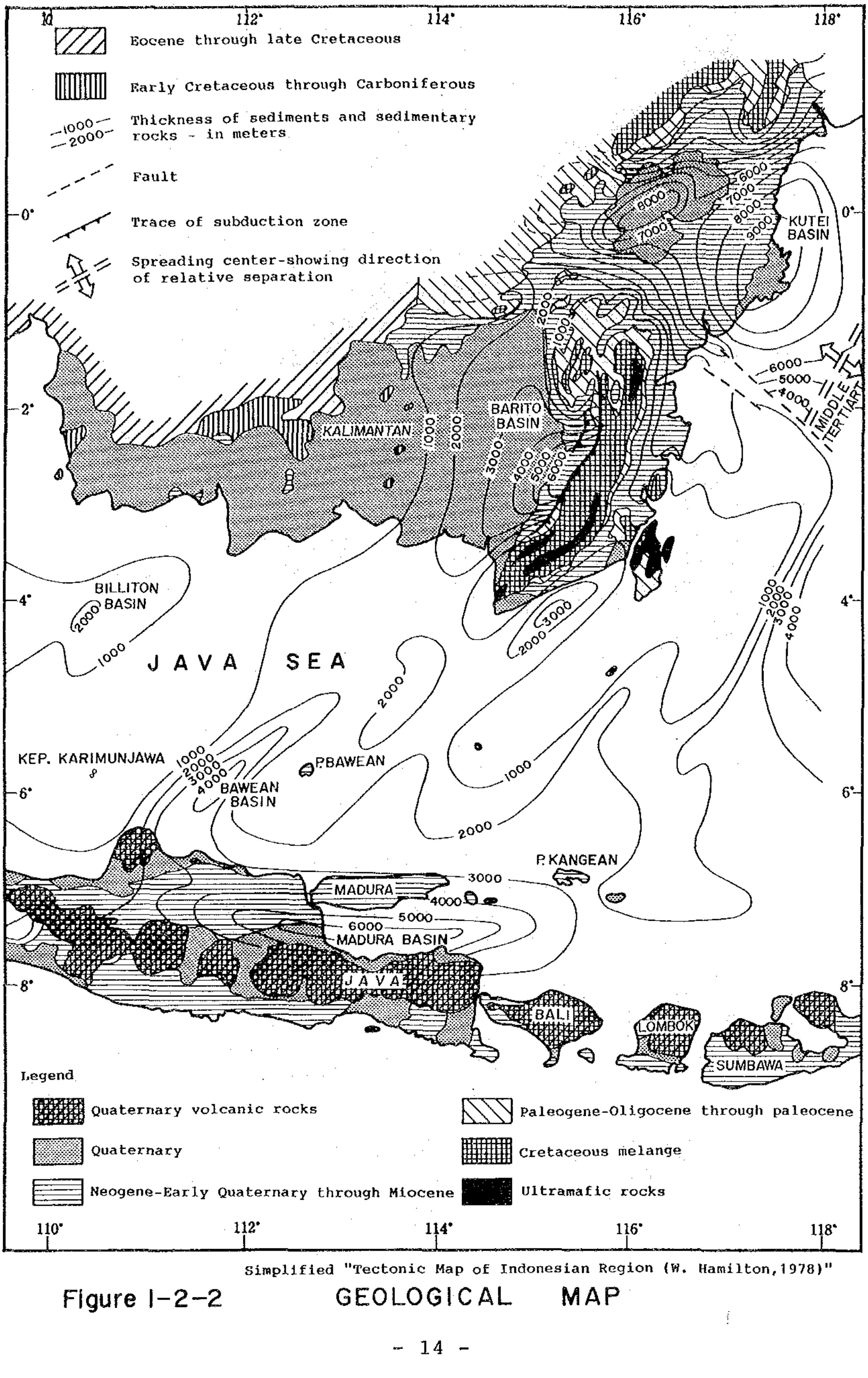


Figure 1-2-1 SUBMARINE TOPOGRAPHY, PALEO-RIVER SYSTEM AND BOTTOM SEDIMENTS
(Modified from K.O.Emery et al,1972)



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

Figure I-2-2 GEOLOGICAL MAP

1-3 Weather, Currents and Water Temperature

The area adjacent to the cable route has a tropical monsoon climate. Typical types of monsoon climate are wet and dry seasons. 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. The season between monsoons is when the periods of the two monsoons change with each other.

In the NW monsoon, the wind mainly blows between W and NW. The wind force is about 2 to 4 (Beaufort scale).

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

In these transitions periods, the wind directions tend to vary. Near the coast, winds are affected by local and irregular variations caused due to topography and local conditions. The effects of land and local breeze may extend up to 10 miles, and occasionally 20 miles from the coast in an extremse case.

The gale accompanied by a squall or a thunderstorm reaches 6 to 7 in terms of wind force, and the wind direction suddenly changes also. Some of the squalls are violent, and it may suddenly develop greater, resulting in temporary hazard to small vessels.

The gale wind (force 8) is rare in this area. There is no record of tropical depressions and cyclones adjacent to the area.

The climate is hot and humid without seasonal variation. In the wet season, the rainfalls is three time as much rain as that in 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 to 29°C throughout a year without seasonal variations.

The currents in the Jawa Sea are governed by the monsoon winds (Figure. 1-3-1). The currents alters directions twice a year due to a difference in wind direction of the two seasons.

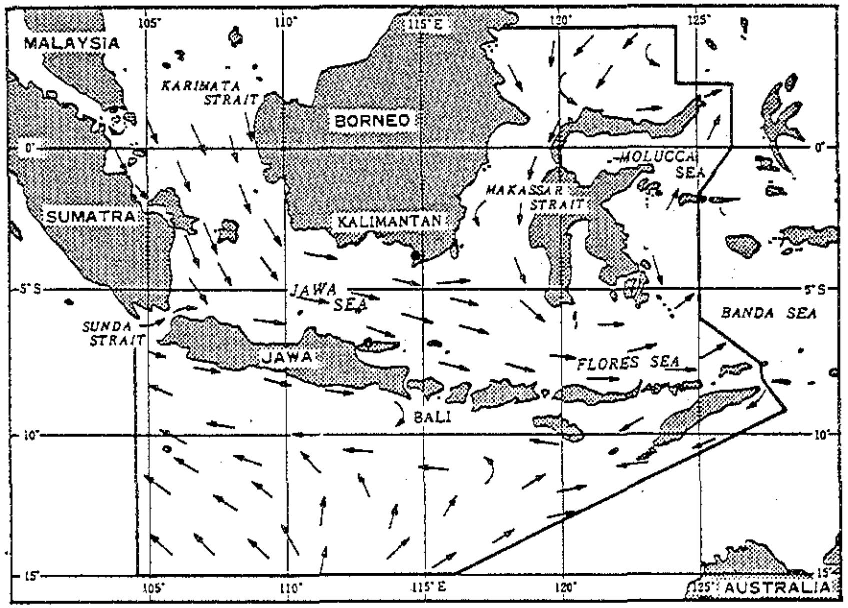
The ocean currents in the Jawa Sea, come from the Pacific ocean. In the NW monsoon, the currents come from the Pacific Ocean via the South China Sea and, in the SE monsoon, from the Pacific Ocean via the Flores Sea.

The dominant current directions coincide with tendency of a monsoon. During the NW monsoon, the current directions are set in the direction between the East and the ESE; during the SE monsoon, these are set in the direction between the West and the WNW.
In a transition from one monsoon season to the other, current direction is high variable.

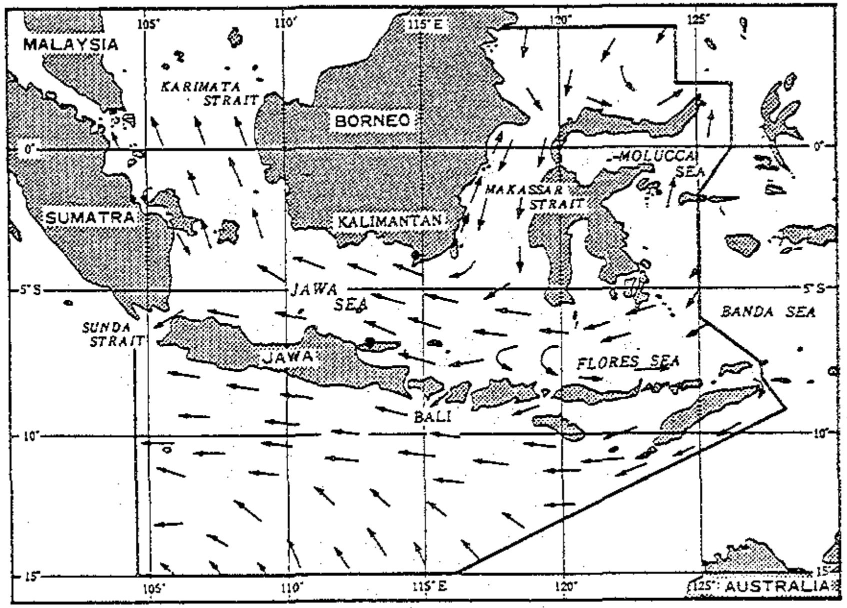
The maximum current velocity rarely exceeds 3 knots at the monsoon transition time. It is generally up to 2 knots. The current velocities are a little stronger in the NW monsoon than in the SE monsoon. The former is on the order of 1.0 to 1.5 knot; the later is about 0.8. The wind waves and swells are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

The tidal streams throughout the area have a marked strong diurnal inequality. This is especially prononced on the coast of Kalimantan and Jawa island facing the Jawa Sea, where the tide is predominately diurnal. The tidal range in the spring tide is about 3 m at Bumi Anyar and about 2.5 m at Takisung.

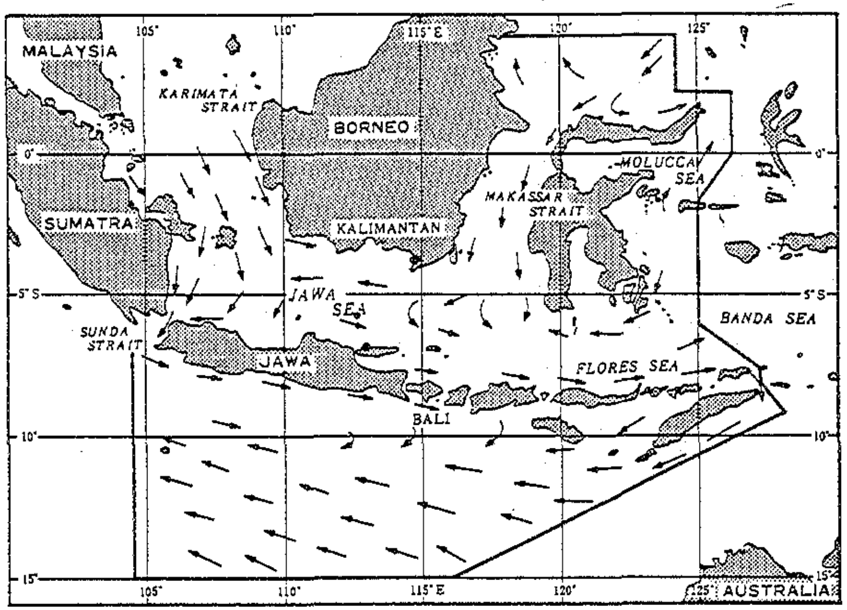
The water temperatures of sea surface varies from 26°C to 29°C. The highest water temperature appears during April and May and, the minimum value appearing in September. Average differences between water and air temperature near the boundary are usually slightly higher in water temperature than that of the air which is in a range of 1°C.



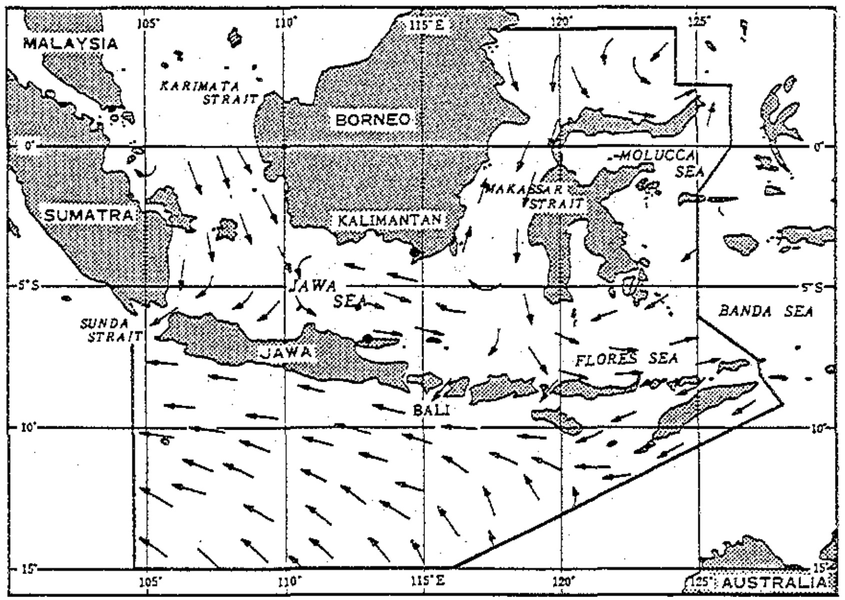
NW Monsoon (February)



SE Monsoon (August)



Monsoon in Transition(April)



Monsoon in Transition(October)

Figure 1-3-1 GENERAL SURFACE CURRENTS CIRCULATION IN THE JAWA SEA (BRITISH PILOT BOOK)

1-4 Fishing Activities

The fishing activities performed on and around the proposed cable route are as follows.

On the coast of Bumi Anyar, the proposed cable route passes through the fishing traps of stone stacking type, utilizing the ebb and flood tide. This type of traps is relatively simple in construction, and the traps may be easily restored to the normal operating conditions even when it is temporarily damaged or destroyed at the time of cable installation. Also, it is believed that this fishing technique itself would not adversely affect the cable even if these fishing traps are built once again at the same location.

In offshore areas at Bumi Anyar and Takisung, small fishing boats are engaged in operations using floating nets, towing nets, towing line, etc. In comparison with these fishing activities in the offshore area, it is considered necessary to take proper steps for protection of cable, such as fishing restrictions or limits, and fishing prohibited area setting, etc.

In February 1986, the JICA survey team conducted a hearing survey, relating to fishing activities at the Directorate General of Sea Communications, 4th Maritime Region in Surabaya. The team was furnished with the following information as a result.

* All trawling has been prohibited since January, 1983 in the whole waters of Indonesia.

* The fishery can operate only within 30 miles from the Indonesian coast.

* The towing net fishing at the middle layer operates within 12 m under the sea surface. (Some exceptions are unavoidable because of water depth.)

However, the team encountered some fishing boats in operation including towing nets, lines, purse seine nets, and fixed floating fishing gears combined by bamboo farther 30 miles off the coast during the ocean survey. Ship activities in connection with fishing boats and fishing gears encountered in the process of the survey by the team in the offshore areas are shown in Fig. 1-5-1.

Upon inquiry made to the Directorate General of Sea Communication, 4th Maritime Region once again about this fact, the team has obtained a reply to the effect that these have been in conflict with the applicable law and/or regulations.

1-5 Shipping Activities

The shipping activities in the Jawa Sea are somewhat complicated, that is the reason why there are some routes among islands or some routes over which vessels pass through straits via the Jawa Sea.

Bumi Anyar and Takisung, both of which are landing points for the proposed cable, locates sufficient distances away from each neighboring principal ports of Surabaya and Banjarmasin port. Therefore, vessels entering and leaving at both port would not make an obstacle to the cable route at coastal areas.

The existing and planning anchoring areas concerned with both ports also would not make an obstacle to the route for the same reason as abovementioned.

At present, the port development planning of Surabaya Port is in progress in the area of Gresik which is located in northwestward neiboring Surabaya. This planned area is limited only to Gresik area, so it would not make an obstacle to the route because of sufficient distance away from Bumi Anyar L.P.

According to the limited information obtained by the Team, in Takisung side, there is a plan to construct a port at Batakan area which is located southward 25 km away from Takisung, but this plan does not effect the cable route because of sufficient distances.

In addition, the survey vessel encountered various type of vessels during Ocean Survey, such as ocean-going cargo vessels, local small boats and fishing boats. Those vessels are summarized in Table 1-5-1 and in Figure 1-5-1.

Table 1-5-1 NUMBERS OF SHIP DURING SURVEY WORK

Section (South Lat.)	Q'ty of Observed Ships	Number of Workdays	Q'ty of Ships/Day
7° ~ 6°	8	4	2
6° ~ 5°	22	2	11
5° ~ 4°	10	4	2.5
4° ~ 3°	3	1	3

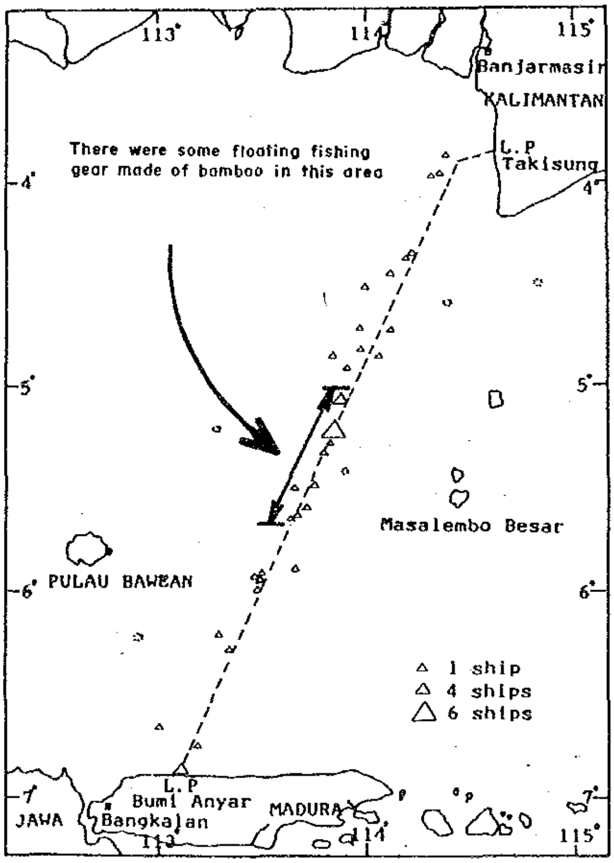


Figure 1-5-1 NUMBERS OF SHIP OBSERVED ADJACENT CABLE ROUTE DURING SURVEY

1-6 Offshore Oil Activities

The petroleum exploitations are under way in many places of the Jawa Sea, especially in its southern part.

The oil companies - KODECO and KERR MCGEE - are performing the petroleum exploitations in the neighborhood of the proposed submarine cable route according to the map of "Petroleum Activity, Indonesia", issued in August 1985 by Petroconsultants, s.a.. The contract areas are indicated in Figure 1-6-1(1),(2). The proposed route from Bumi Anyar landing point to the altered course No.2 via No.1 is passing through roughly on the eastern boundary line of KODECO's contract area.

The relationship between the proposed route and KODECO's contract area is shown in Figure 1-6-2 in detail. It is understood that the proposed route runs more than 2 km away from the eastern end of KODECO's contract area. In KODECO's area, Poleng Oil Field is under development, and numerous oil structures exist in that oil field. The positions of those structures and the prohibitive area to enter are also indicated in Figure 1-6-2, and the coordinates of those are listed in Table 1-6-1.

Petroleum activities are still intact at other parts of the proposed route at this stage as yet. However, PERTAMINA is planning to commence the petroleum exploitation in the northern part of the Jawa Sea off the southeastern Kalimantan in the near future. PERTAMINA was open to receive tenders for the petroleum exploitation in the area, namely BATAKAN BLOCK as shown in Figure 1-6-3, until the end of May, 1986. Therefore, the movement of this activity shall be watched for this submarine cable project.

The oil and gas wells drilled near the proposed cable route are scattered around the proposed route, as shown in Figure 1-6-1(1),(2). In this figure, the white circle indicates a dry hole, and the black circle indicates detection of oil or gas. The coordinates of those wells existing in close proximity to the proposed route are listed in Table 1-6-2, based on the letter from PERTAMINA dated April 4, 1985 and the hearing from PERTAMINA in March, 1986. All of the listed wells are dry holes and therefore, these had to be abandoned. In this table, the distance from the proposed route at each well is also indicated. The well "JS 14A - 1" is nearest to the proposed route and the distance is 1.1 n.m.. In our opinion, the laying of submarine cable along the proposed route is free from the existing and abandoned wells of oil and gas, if the adequate positioning system is employed during construction.

Table 1-6-1(1) LIST OF STRUCTURES IN POLENG OIL FIELD, KODECO

Name of Structure	Coordinates	
	Latitude	Longitude
Platform "AW"	6°39'38.7"	112°55'06.3"
Platform "BW"	6°41'15.9"	112°54'34.0"
Flare	6°39'29.4°	112°55'06.5"
S.B.S*	6°38'42.4"	112°55'23.2°

* : Single Buoy Storage

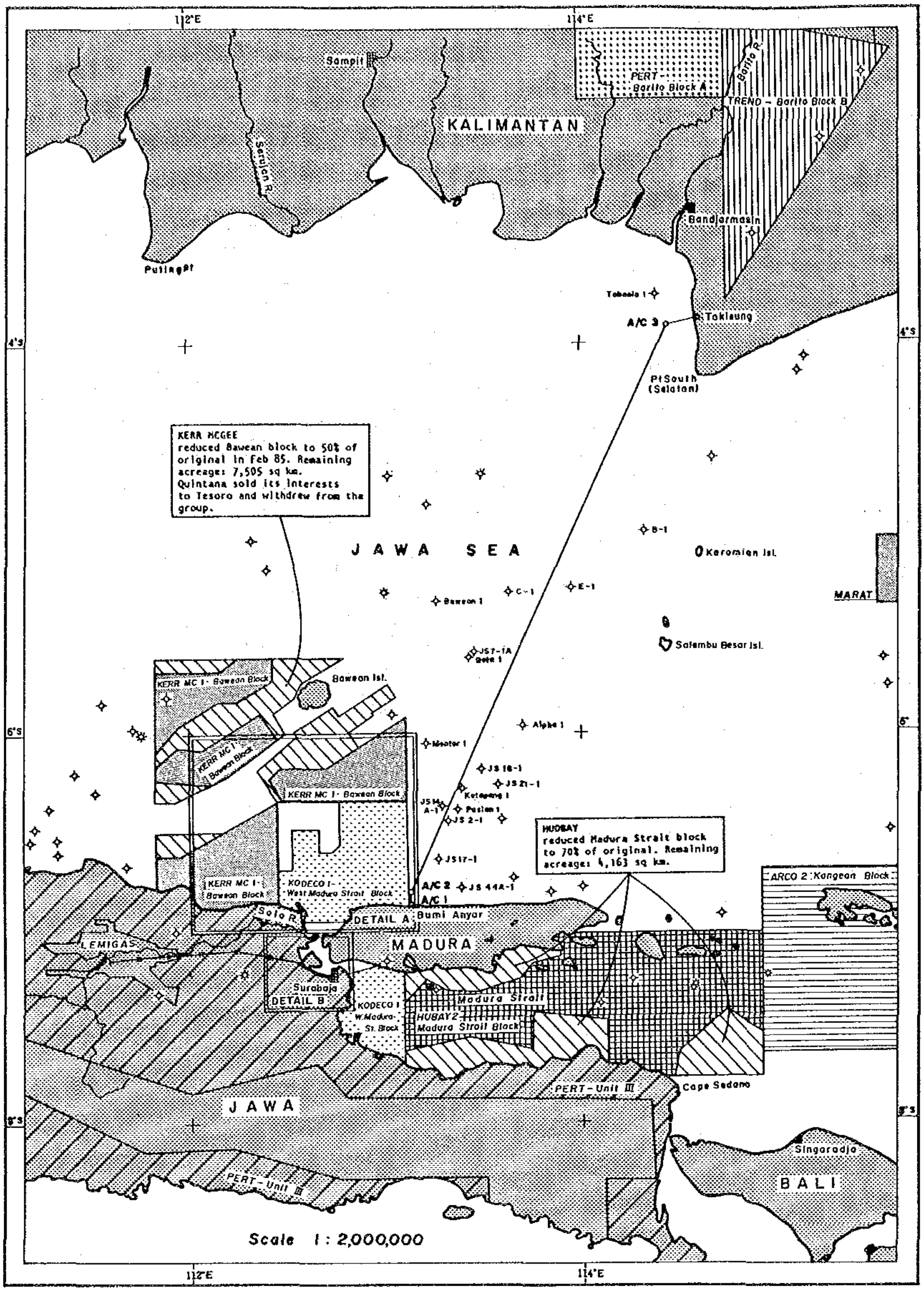
Table 1-6-1(2) COORDINATES OF PROHIBITIVE AREA IN POLENG OIL FIELD, KODECO

Prohibitive Area to Enter	Coordinates	
	Latitude	Longitude
A	6°37'19.2"	112°54'36.0"
B	6°37'54.6"	112°56'45.8"
C	6°39'00.0"	112°57'46.0"
D	6°42'58.0"	112°54'18.0"
E	6°41'07.0"	112°53'46.0"
F	6°39'00.0"	112°55'15.0"

Table 1-6-2 LIST OF WELL ALONG PROPOSED CABLE ROUTE

Name of Well	Coordinate		Distance from Route	Name of Oil Company
	Latitude	Longitude		
Tobanid 1	3°45'11.25"	114°22'25.0"	10.1 N.M	Ashland
E - 1	5°15'08.137"	113°57'37.806"	7.2	Ashland
C - 1	5°16'17.84"	113°38'26.27"	9.8	Ashland
JS 7 - 1A	5°35'30.0"	113°27'20.0"	11.9	ICSI
Beta 1	5°37'08.0"	113°25'46.0"	12.7	Pexamin
Alpha 1	5°58'03.1"	113°42'02.5"	10.7	Houston Oil
Montor 1	6°02'02.50"	113°11'55.07"	15.0	Union Oil
JS 18 - 1	6°11'29.64"	113°29'35.82"	5.0	ICSI
Ketapang 1	6°17'50.89"	113°22'50.34"	1.5	Union Oil
Pasian 1	6°24'04.449"	113°22'30.142"	3.8	Union Oil
JS 14A - 1	6°23'04.45"	113°17'28.83"	1.1	ICSI
JS 2 - 1	6°27'10.0"	113°19'20.0"	2.2	ICSI
JS 17 - 1*	6°39'00.0"	113°16'30.0"	4.4	ICSI
JS 44A - 1	6°47'44.0"	113°23'12.0"	14.3	ICSI
KE - 4	6°24'41.86"	113°04'45.85"	12.1	KODECO
JS 19 - 1	6°47'22.0"	113°05'50.0"	1.7	ICSI

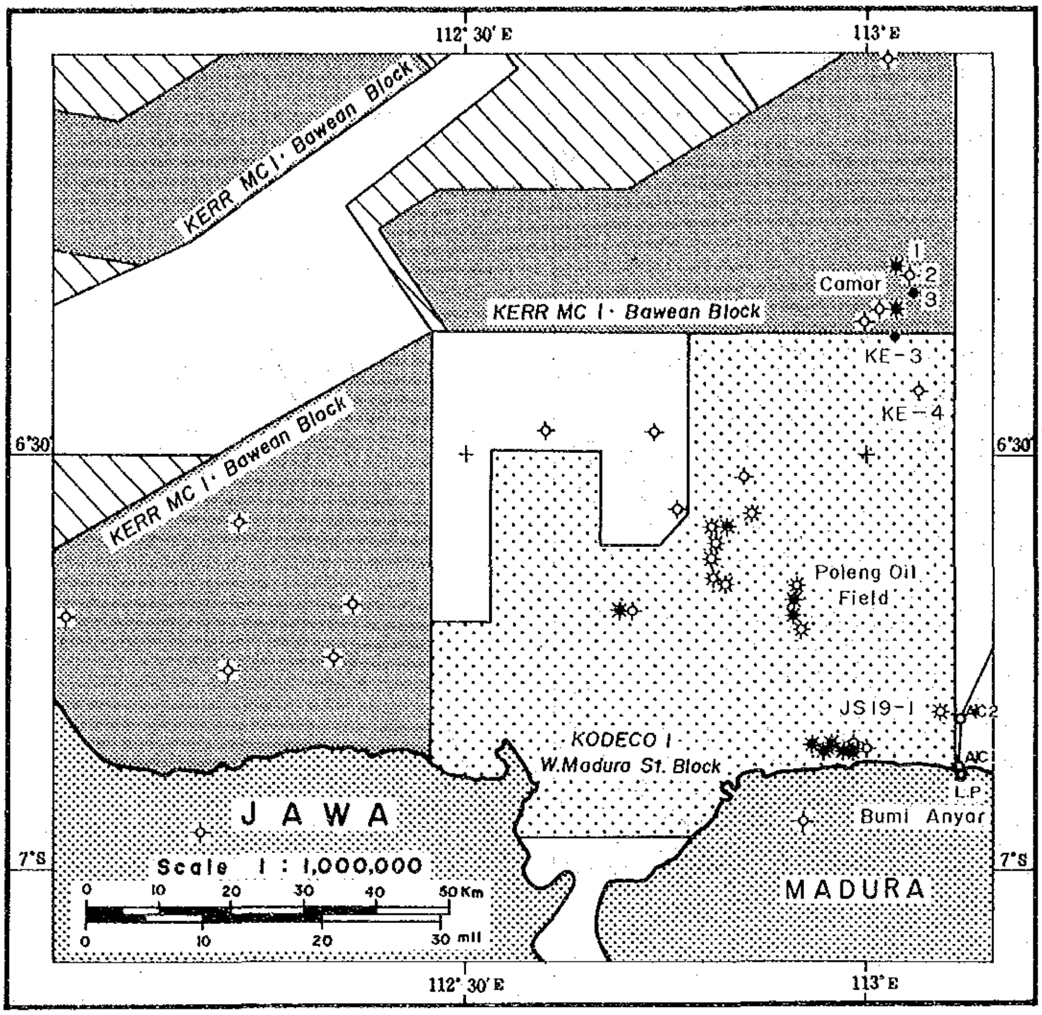
* : The coordinate of this well is based on the map of "petroleum Activity Indonesia".



Modified from "Foreign Scouting Service, PetroleumActivity, Indonesia (Petroconsultants, s.a., August 1985)"

Figure I-6-1(1) PETROLEUM ACTIVITIES IN EASTERN JAWA SEA

DETAIL A



DETAIL B

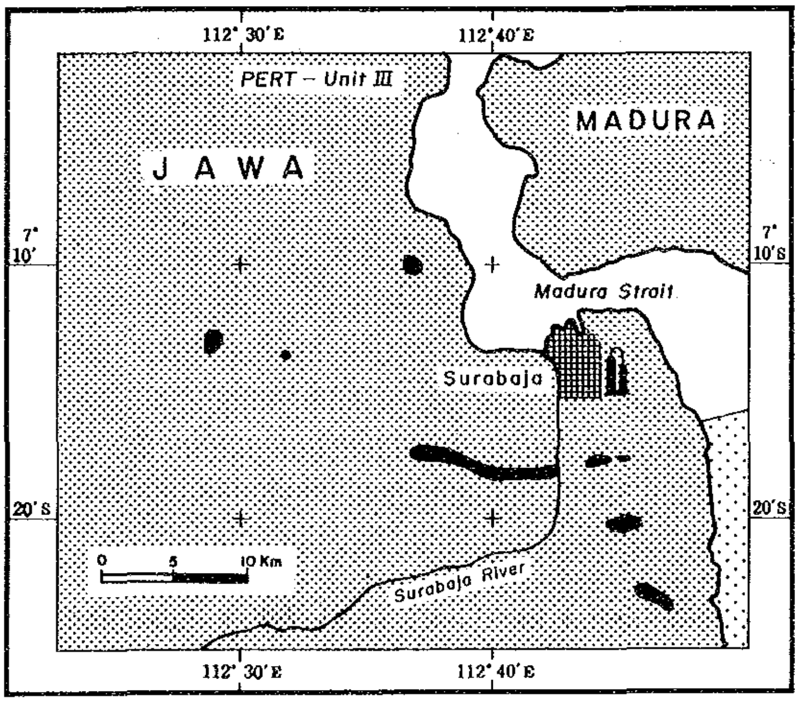


Figure I-6-I(2) PETROLEUM ACTIVITIES IN EASTERN JAWA SEA

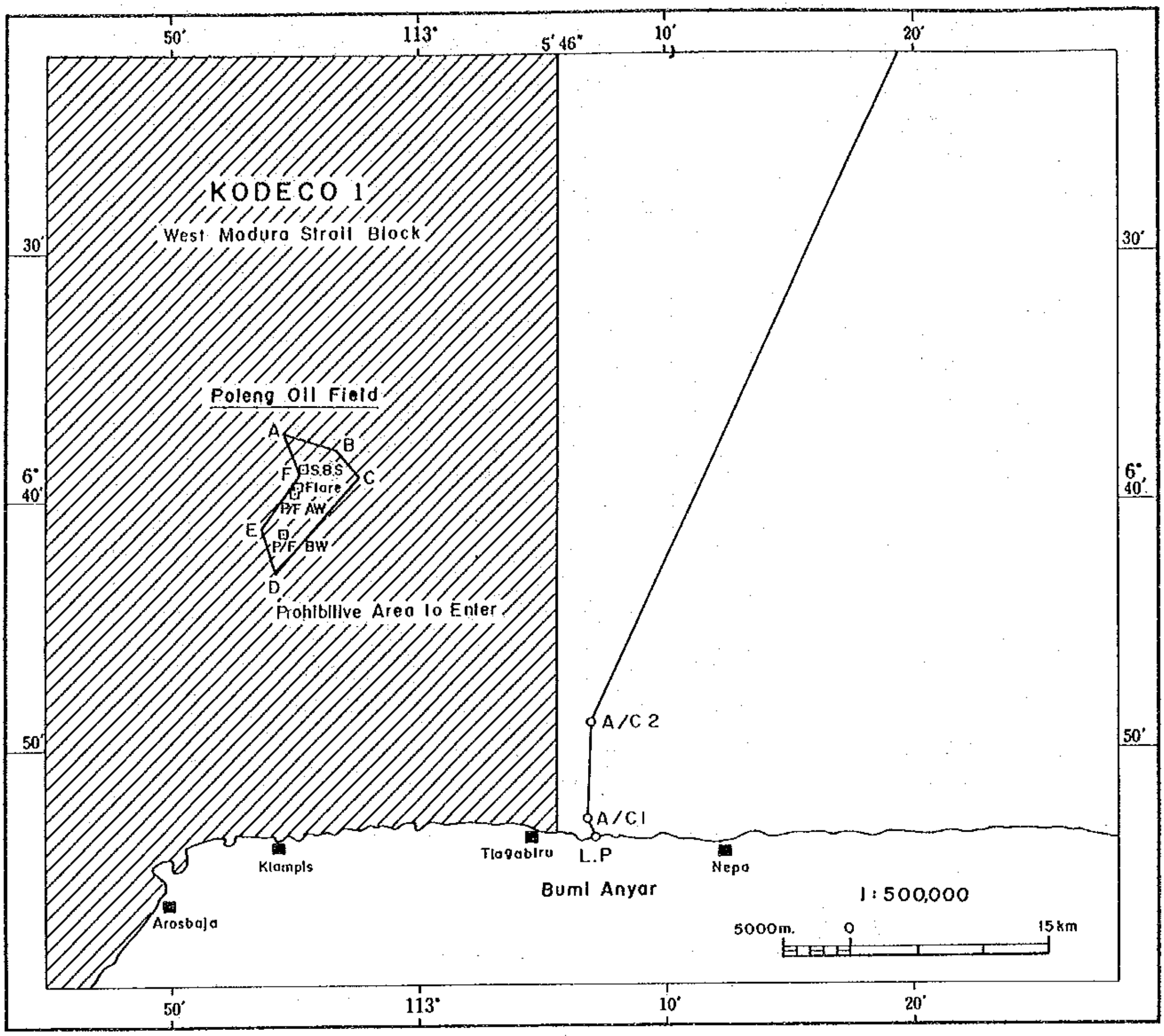
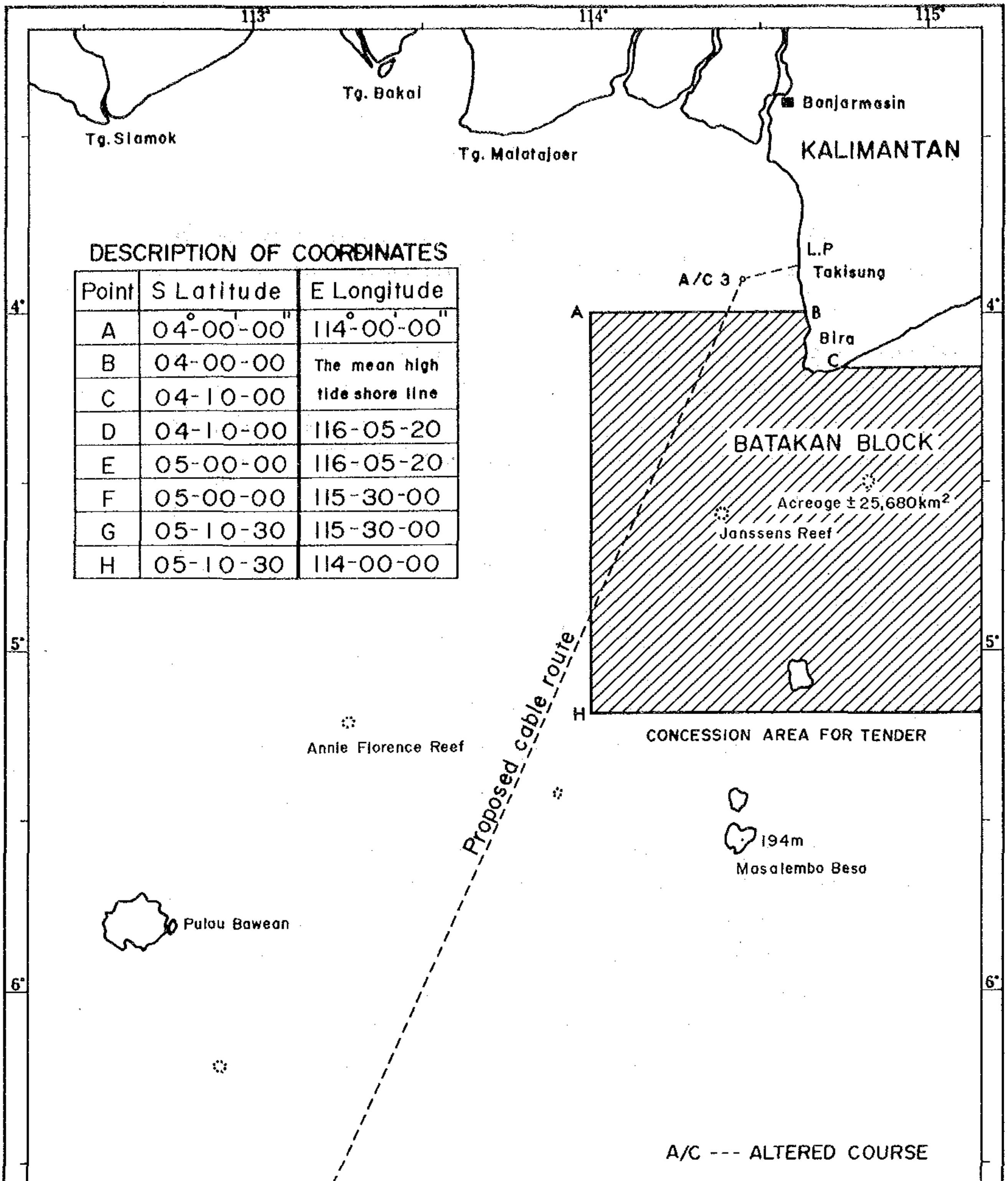


Figure 1-6-2 RELATIONSHIP BETWEEN PROPOSED CABLE ROUTE AND KODECO'S CONTRACT AREA



DESCRIPTION OF COORDINATES

Point	S Latitude	E Longitude
A	04°-00'-00"	114°-00'-00"
B	04-00-00	The mean high tide shore line
C	04-10-00	
D	04-10-00	116-05-20
E	05-00-00	116-05-20
F	05-00-00	115-30-00
G	05-10-30	115-30-00
H	05-10-30	114-00-00

Figure I-6-3 CONCESSION AREA FOR TENDER

1-7 Mine Dangerous Area

Some mine dangerous areas where mines have been installed during the World War II exist in the coastal area at Bumi Anyar, adjacent to the proposed cable L.P.

The Team confirmed the non-swept area (Fig. 1-7-1) in the coastal area at Bumi Anyar, based upon the existing nautical charts and pilot books. For this reason, the Team gathered further information on the mine from the Indonesian authorities concerned and the Japan authorities concerned as following:

1. Even if mine swept area, does not mean that the removing mines have been completly carried out.
2. The possibility of mine existence in the non-swept area.
3. The nature of the induced magnet mine.
4. The state in which the mine has gone off.
5. Accident caused by mine did not happen in the coastal area at Madura island.

The Team totally examined about the above-mentioned informations. As a result of the examination, the Team judged that more than 40 years have passed since the mine had been installed, but the mine might or might not still stand the possibility of explosion depending upon the extent of corrosion of mine battery and fire mechanism. It has therefore been decided to perform a magnetic survey in the non-swept area for ensuring safety at the time of cable installation (See Figure 2-2-5).

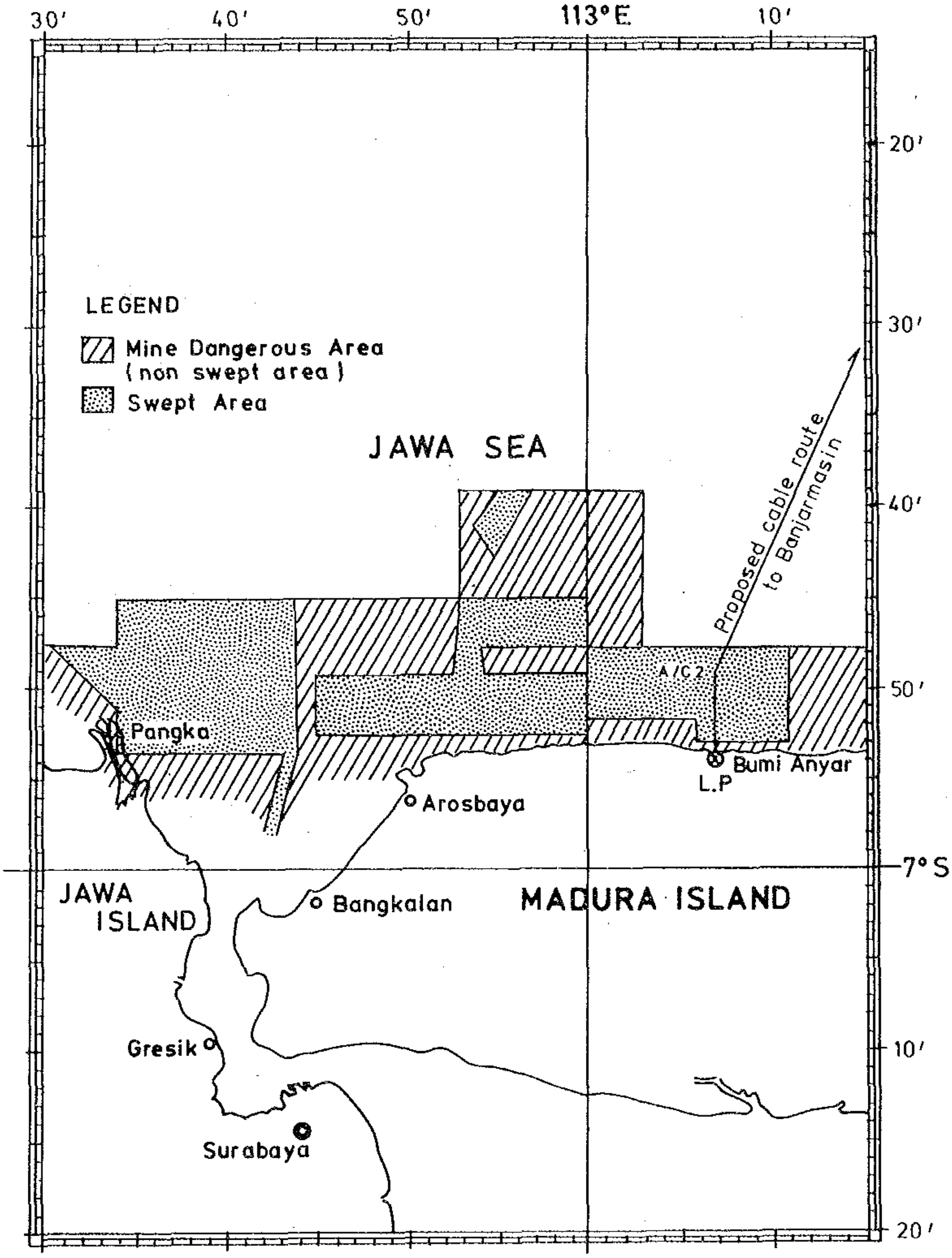


Figure I-7-1 MINE DANGEROUS AREA

CHAPTER 2 COASTAL SURVEY

CHAPTER 2 COASTAL SURVEY

2-1 General

Both of the landing points (L.P) and survey route at/between Bumi Anyar and Takisung were examined on the basis of the nautical charts and the data on geology, minning/pertroleum area and dangerous mine area. Those were well discussed by and among the authorities concerned of Indonesia and the JICA Team.

The surveys were conducted using the survey vessel "KAIKO MARU No. 5" and some local boats which were chartered by the Team. The seabed photographing by divers was suspended for reason of turbid seawater. The following items were surveyed in coastal areas.

(1) Control point survey
(2) Sounding
(3) Sea bottom scanning
(4) Seismic profiling
(5) Sea bottom sampling
(6) Sea bottom photographing (tidal area only)
(7) Water thermometry
(8) Current observation
(9) Topographic feature survey around L.P
(10) Earth specific resistivity survey
(11) Magnetic survey (at Bumi Anyar)

2-2 Bumi Anyar

2-2-1 Shallow Water Survey

The items and contents of Shallow Water Survey are summarized in Table 2-2-1 which were carried out for clarifying submarine topography, geology, current observation and water thermometry at the coastal area in Bumi Anyar.

Table 2-2-1 ITEMS AND CONTENTS OF SHALLOW WATER SURVEY

Survey Item	Survey Method	Objective Area
Topographic survey	Leveling	Tidal zone
	Lead survey	Area about 700 m away from L.P
	Echo sounding	Area between the area of lead survey and the point 3,800 m off A/C 1
Side-scanning survey	Side scan sonor	Area same as echo sounding area
Sub-bottom survey	Driving iron rod	Tidal zone
	Sub-bottom profiler (Sonoprobe)	Area same as echo sounding area
Bottom material survey	Walking survey	Tidal zone
	Piston corer & diver	Area same as echo sounding area
Current observation and water thermometry	Aanderaa Current-meter (RCM-4)	Whole water area (Fixed Points)
	Electric thermometer (ET-5)	Whole water area (Fixed Points)

For further details, refer to "Appendix 3. Survey Equipments and Survey Methods".

The submarine topography, geology, currents observation and water thermometry at the coastal area in Bumi Anyar are described hereinafter based on the results of the Shallow Water Survey mentioned above. For the detailed results, refer to "Appendix (4. Result of Physical and Chemical Analysis for Bottom Material, 5. Oceanographic Station Data for Sampling and Deep Sea Photographing, and 10. Results of Side Scanning)"," Vol. IV Figures and Drawings (1. Coastal Survey Tracks (Bumi Anyar), 2. Bathymetric and Contour Chart (Bumi Anyar), 3. Bottom Profile and Sub-bottom Layers (Bumi Anyar)".

(1) Submarine Topography

A general view of the topography along the proposed cable route from L.P to the end of shallow Water Survey area, which is located 5.3 km away from L.P. is as follows.

A relative steep slope near L.P (height:3.1 m) immediately changes to a flat plane (height:+1.0-0.0 m), which is about 600 m in width. The flat plane has a sand bank at the landward end of this plane and also coral reefs at the seaward side of this plane. The seafloor drops to the level of -6.0 m from the seaward end of this flat plane with a slope gradient 1/70. The distance is 1,050 m between L.P and the level of -6.0 m along the proposed route.

The seafloor uniformly drops to the level of -19.0 m from the level of -6.0 m with a gentle slope. The gradient of the slope is 1/320. The level of -19.0 m is located at the farest end of Shallow Water Survey area.

(2) Submarine Geology

The distribution of bottom materials is as follows. Well-sorting Medium Sand is distributed around L.P. Muddy Sand is accumulated in the through between L.P and the sand bank. Fine-Medium Sand is distributed on the area of the flat plane except on the distributed area of Coral Reefs. The distributed area of Fine-Medium Sand is about 350 m in length along the proposed route. This Fine-Medium Sand has regular ripple marks in places. Coral Reefs begin to be distributed near the seaward end of the flat plane. It is estimated that the distribution of Coral Reefs ends at the midway of the relative steep slope mentioned above, the gradient of which is 1/70. The distributed area of Coral Reefs is about 300 m in length along the proposed route. Sandy Mud is uniformly distributed beyond the area of Coral Reefs until it reaches the end of Shallow Water Survey area.

The stratum of the coastal area in Bumi Anyar is divided into two layers based on the shallow seismic data. The lower layer is estimated to be the complex of Recent Coral Reefs and Old-type Reef Limestone because of the rough surface of this layer and the existence of Old-type Reef Limestone on the shore. The upper layer is estimated to be Recent Sedimentary Layer, which is accumulated on the complex mentioned above. Within the Sedimentary Layer several bedding planes are continuously recognized. The tongue-like sedimentary structure elongated seaward is seen in the bedding planes. No erosion plane is found within this Sedimentary Layer. It is estimated that the layer from the seabed to at least about 2.0 m below seabed shall be uniformly Sandy Mud because of no existence of bedding planes within this range.

The depth of the complex of Recent Coral Reefs and Old-type Reef Limestone below seabed is as described below along the proposed cable route. The complex exists at the level of at least more than 1.5 m in the area between L.P and the Coral Reefs near the end of the flat plane, when judged on the basis of the results of the penetration survey by using an iron rod which is 1.5 m length. The complex comes out near the seaward side of the flat plane, and goes under the seabed at the midway of the slope whose gradient is 1/70. The depth of the surface of the complex is nearly 5.0 m below seabed at the break point of topography, where the gradient of the slope changes 1/70 to 1/320. And the depth is nearly 10.0 m below seabed around the point, which is about 2.0 km away from L.P along the proposed route. The complex is not recognized on the seismic record seaward from the point mentioned above because the complex goes deeply under the seabed.

(3) Currents and Water Temperature

According to the current direction-velocity distribution (Table 2-2-2, Fig. 2-2-1) obtained from the results of 15 days contineous current observation at st.A-1 (water depth 17 m), direction on NNE, distance about 3.5 km off Bumi Anyar L.P, followings were considered.

All of the current directions at upper layer (under seasurface 5 m) appeared between NE and SE. The 83.5% of them occupied the East direction. The current velocities at upper layer were 74.6 cm/s (1.5 knots, direction E) at max. and 43.3 cm/s (0.8 knots) at mean, respectively.

The current directions at lower layer (above seabed 1 m) appeared mainly between NE and SE as well as those at upper layer. The rate of the appearance of that direction was 64.5%. On the other hand, 18.6% of directions appeared westerly, between NW and SW in lower layer. The current velocities at lower layer were 38.2 cm/s (0.7 knots, East) at max. and 15.7 cm/s (0.3 knots) at mean in the Easterly currents, and 19.7 cm/s (0.4 knots, W and WSW) at max. and 11.5 cm/s (0.2 knots) at mean in the Westerly currents.

The current velocities at upper layer were around two times in comparison with those at lower layer.

The current direction-velocity curve (Fig. 2-2-2) shows that semi-diurnal and or diurnal period (a half day and or a day period) appeared in the current velocity variations with dominated Easterly currents at upper and lower layers.

Further, the variations of current velocities well corresponded between the upper and lower layers. When the current velocity at upper layer becomes small, it can be seen that the current at lower layer occasionally flows in the opposite direction.

Judging from the foregoing, it seems that the current at both layer in the coastal area at Bumi Anyar has a nature of drift current caused by the NW monsoon wind and are affected by tidal streams with a semi-diurnal and or a diurnal period.

To determine the current drift, the vector progress diagrams was drawn Figure 2-2-3. The diagrams shows that the current had some discrepancy in the current velocities and some deviated directions between the upper and lower layers. However, the currents at upper and lower layers had the tendency of easterly stream.

The water thermometry was carried out at 5 stations along the cable route up to a distance of about 1.6 to 5 km offshore from the L.P. The results of water thermometry are shown in Table 2-2-3 and Fig. 2-2-4.

According to these results, followings were described. Maximum water temperature at sea surface (under seasurface 0.5 m) was 28.4°C at st.AM-104 about 4.3 km away from the L.P., and min. water temperature was 27.8°C at st.AM-105 about 0.7 km away from st.AM-104.

The range of water temperature between the upper and lower layers at each station are very little. The maximum range was 1.1°C at st.AM-104 (water depth 15.8 m). The vertical variations at each stations are shown in Figure 2-2-4.

Table 2-2-2 CURRENT DIRECTION-VELOCITY DISTRIBUTION

(1)

(Direction) unit : %

Direction \ St.	A - 1 (Upper)	A - 1 (Lower)
Northernly (NW-NE)	—	1.2
Easterly (NE-SE)	100	64.5
Southernly (SE-SW)	—	15.7
Westerly (SW-NW)	—	18.6

(2)

(Velocity) unit : cm/s

St. \ Direction	Northernly		Easterly		Southernly		Westerly	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean
A-1 (Upper)	—	—	74.6 (E)	43.3	—	—	—	—
A-1 (Lower)	17.2 (NW, NNW)	11.8	38.2 (E)	15.7	25.0 (SE)	13.3	19.7 (WSW, W)	11.5

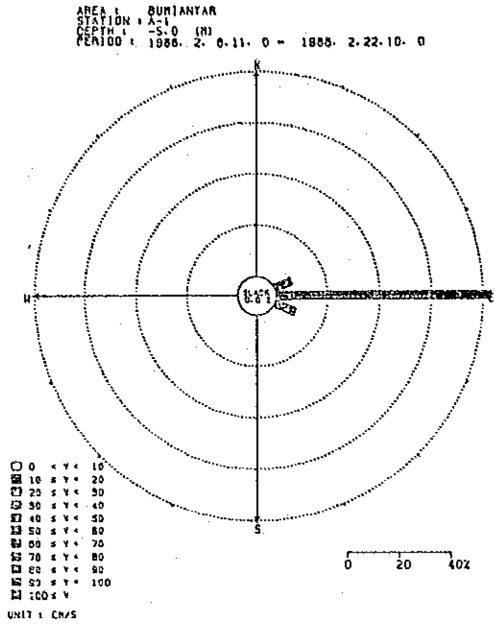
( ): The current direction at Max. Velocity appeared

Table 2-2-3 RESULTS OF WATER TEMPERATURE

Station (Depth: m)	AM 105 (18.2)	AM 104 (15.8)	AM 103 (13.2)	AM 102 (10.2)	AM 101 (8.0)
Layer \ Time	6:58 ~ 7:00 Feb. 11	8:54 ~ 8:58	9:30 ~ 9:31	9:55 ~ 10:00	10:22 ~ 10:25
(m) Sea surface -0.5	27.8	28.4	28.1	28.1	28.1
1.0	27.8	28.4	28.1	28.1	28.1
2.0	27.8	28.4	28.1	28.1	28.1
3.0	27.8	28.4	28.1	28.1	28.1
4.0	27.7	28.4	28.1	28.1	28.1
5.0	27.7	28.4	28.1	28.1	28.1
6.0	27.6	28.2	28.1	28.1	28.1
7.0	27.6	28.1	28.1	28.1	28.1
8.0	27.6	28.1	28.1	28.1	
9.0	27.6	28.1	28.1	28.0	
10.0	27.6	27.9	28.0		
Seabed +1.0	27.6	27.3	27.5	27.6	28.1

BUMIANYAR A-1 -5.0 m
1986. 2. 8 11: 0 - 1986. 2.22 10: 0

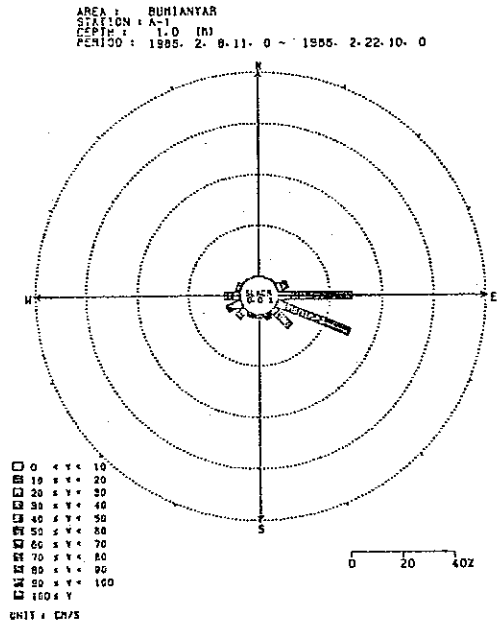
Dir. \ cm/sec	0-	10-	20-	30-	40-	50-	60-	70-	80-	90-	100-	Total
-	0 0.0											0 0.0
N	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
NNE	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
NE	0 -	0 -	0 -	1 0.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.0
ENE	0 -	0 -	26 1.3	59 2.9	46 2.3	14 0.7	5 0.2	0 -	0 -	0 -	0 -	150 7.5
E	0 -	0 -	127 6.3	582 28.9	535 26.6	325 16.2	91 4.5	20 1.0	0 -	0 -	0 -	1680 83.5
ESE	0 -	0 -	11 0.5	58 2.9	65 3.2	32 1.6	13 0.6	1 0.0	0 -	0 -	0 -	180 9.0
SE	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
SSE	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
S	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
SSW	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
SW	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
WSW	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
W	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
WNW	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
NW	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
NNW	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -
Total	0 -	0 -	164 8.2	700 34.8	646 32.1	371 18.4	109 5.4	21 1.0	0 -	0 -	0 -	2011 100.0



Upper Layer (5.0 m under the sea surface)

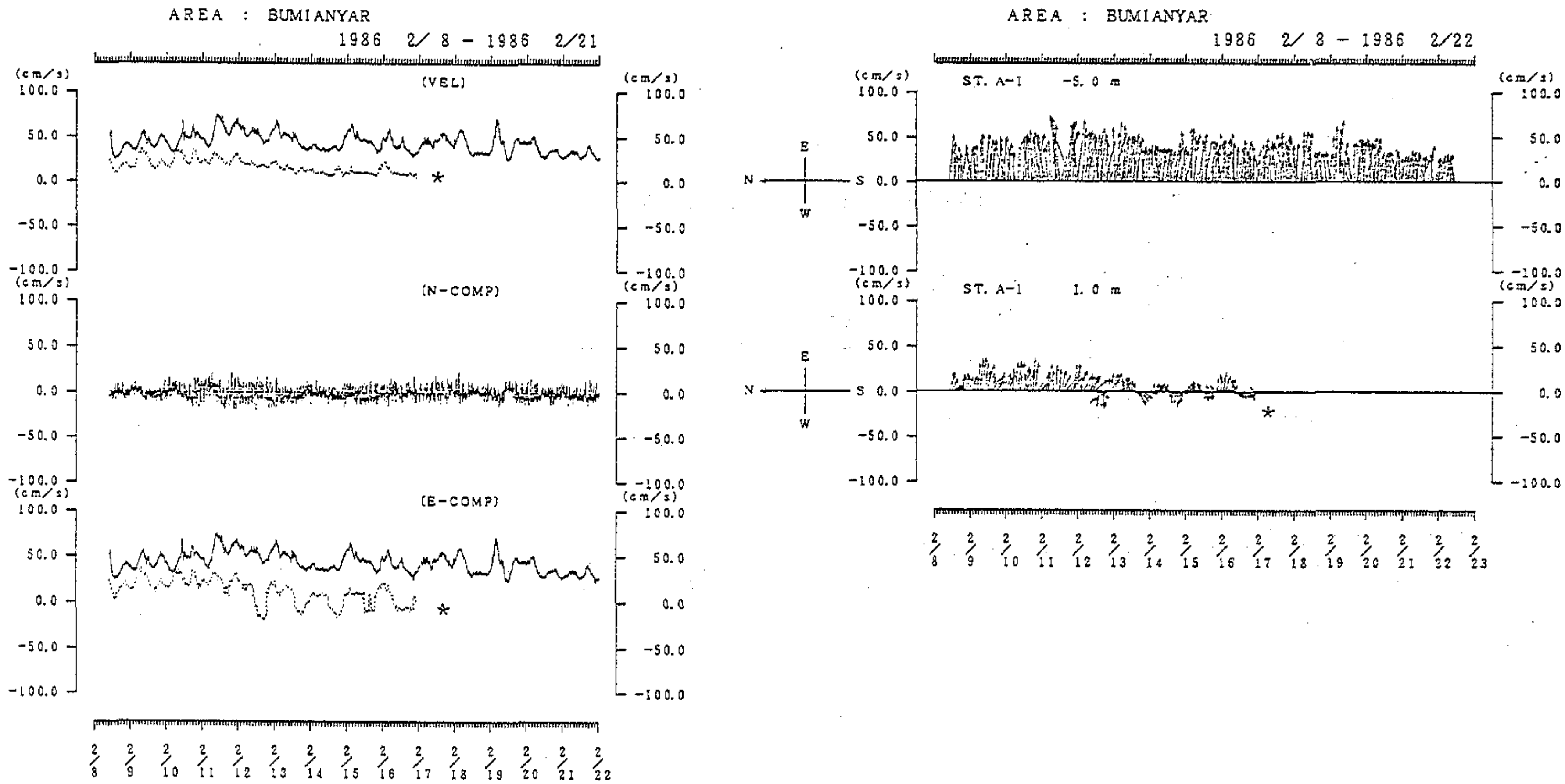
BUMIANYAR A-1 1.0 m
1986. 2. 8 11: 0 - 1986. 2.22 10: 0

Dir. \ cm/sec	0-	10-	20-	30-	40-	50-	60-	70-	80-	90-	100-	Total
-	0 0.0											0 0.0
N	1 0.1	2 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 0.2
NNE	1 0.1	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	2 0.2
NE	6 0.5	3 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 0.7
ENE	24 2.0	21 1.7	8 0.7	4 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	57 4.7
E	38 3.1	126 10.3	110 9.0	77 6.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	351 28.7
ESE	49 4.0	191 15.6	122 10.0	10 0.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	372 30.4
SE	23 1.9	74 6.1	22 1.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	119 9.7
SSE	10 0.8	19 1.6	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	30 2.5
S	2 0.2	21 1.7	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	23 1.9
SSW	10 0.8	10 0.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	20 1.6
SW	30 2.5	26 2.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	56 4.6
WSW	40 3.3	34 2.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	74 6.1
W	34 2.8	39 3.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	73 6.0
WNW	5 0.4	19 1.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	24 2.0
NW	4 0.3	3 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	7 0.6
NNW	1 0.1	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	2 0.2
Total	278 22.7	590 48.3	263 21.5	91 7.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1222 100.0



Lower layer (1.0 m above the seabed)

Figure 2-2-1 CURRENT DIRECTION/VELOCITY FREQUENCY DISTRIBUTION AT BUMI ANYAR OFFSHORE

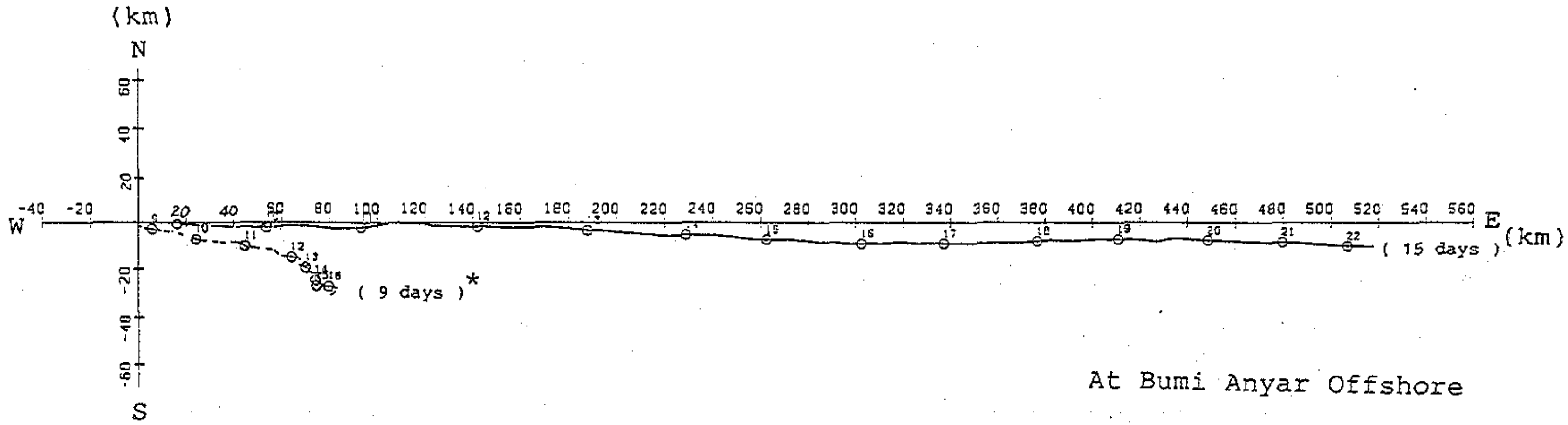


━━━ Upper Layer (5.0 m under the sea surface)

•••• Lower Layer (1.0 m above the seabed)

* Short data due to cuttlefish roe attached on the rotator of current meter.

Figure 2-2-2 CURRENT DIRECTION/VELOCITY CURVE AT BUMI ANYAR OFFSHORE (15 DAYS CONTINUOUS OBSERVATION)



— Upper Layer (5.0 m under the sea surface)

--- Lower Layer (1.0 m above the seabed)

* Lower layer is 9 days short data due to cuttlefish roe attached on the rotator of current meter.

Figure 2-2-3 PROGRESSING VECTOR DIAGRAM

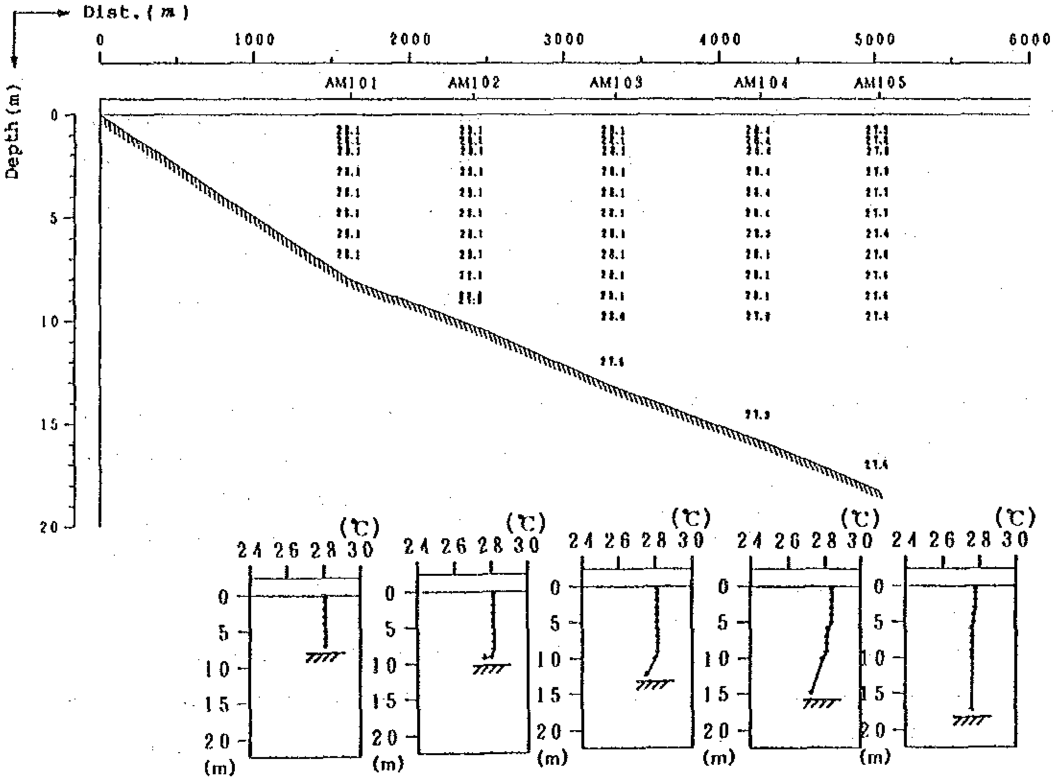


Figure 2-2-4 WATER TEMPERATURE IN VERTICAL VARIANCE AND PROFILE AT OFFSHORE

2-2-2 Magnetic Survey

Dangerous mine areas, where mines were installed during the Warld War II exist in vicinity of the planned L.P at Bumi Anyar in Madura island (See Fig. 1-7-1). Therefore, a magnetic survey was conducted along the planned cable route extending over a distance 1,700 m through the non-swept area to secure the safety of the cable laying work.

In search for dangerous objects such as mines, the magnetic survey technique is generally employed with good reults obtained in Japan, utilizing the principles that mines are made of iron, which is ferromagnetic metal. A magnetic meter used is towed by a boat or hand-carried for measurement.

In this survey, the area for mine survey was established as the centerline of the proposed cable route, 100 m wide at shallow water area and 200 m wide at deeper water area. The tracks of moving of magnetic meter and observation boat are shown Vol. IV in Figures and Drawings (Fig. 11. Magnetic Survey's Boat Tracks and Magnetic Anomarous Points).

As a result of magnetic survey, some magnetic anomalies were found. Most of them had small magnetic charge below 1 gauss.cm^2.
It appeared that they were to be not mines. But at 3 magnetic anomalous points magnetic charge above 10 gauss.cm^2 were confirmed. Especially, one of them had 26 gauss.cm^2. This value is well within the range of mine's value between 25 and 300 gauss.cm^2. The 26 gauss.cm^2 is at the lowest value of this range, but the Team can not assert that this magnetic anomaly is cuased by mine or not. These 3 anomalous points are shown in Fig. 2-2-5. The estimated values are listed in Table 2-2-4.

Table 2-2-4 LIST OF MAGNETIC ANOMALIES

Anomaly ST.No.	Quantity of Magnetic Charge	Buried Depth (m)	Location		Remarks
			X (m)	Y (m)	
1	26*)	0.6 - 0.8	1200.0	E87.0	*) within the range of mine's value
2	14	0.8 - 1.2	70.0	E32.0	
3	10	0.6 - 1.0	23.0	W32.0	

X and Y in the columns of location represents a distance from L.P along the cable route and a distance from the centerline of cable, respectively. E and W in the columns of location indicate east and west, respectively. The position of ST. No.1 is as given below:

Latitude:--------- 6°53' 01.242" (S)

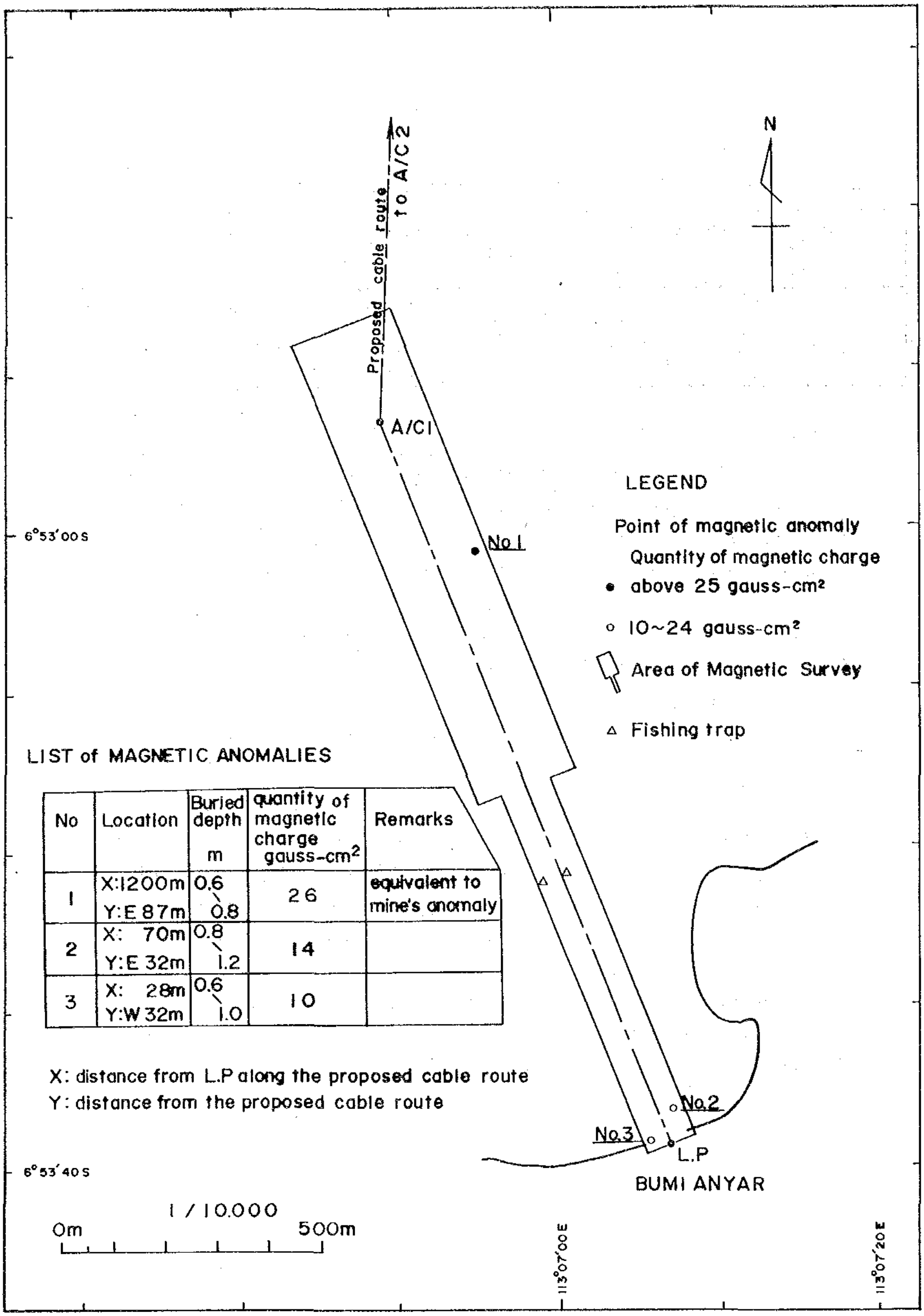
Longitude:------ 113° 06' 55.342" (E)

From L.P

Direction:------ 342° 56' 20.84"

Distance:------- 1203.4 m

With regard to Anomaly ST. No.2 and No.3, it seems that there is no existence of mine. Regarding Anomaly ST. No.1, the possibility of the existing mine is little, but it is necessary to be made some idea for mine before cable laying. For example, the location of anomaly should be indicated, but at this place, no strong impact should be given on the construction. Or, the presence of the magnetic abnormal object should be confirmed by diver prior to undertaking the cable laying.



LIST of MAGNETIC ANOMALIES

No	Location	Buried depth m	quantity of magnetic charge gauss-cm²	Remarks
1	X:1200m Y:E 87m	0.6 ~ 0.8	26	equivalent to mine's anomaly
2	X: 70m Y:E 32m	0.8 ~ 1.2	14	
3	X: 28m Y:W 32m	0.6 ~ 1.0	10	

X: distance from L.P along the proposed cable route
Y: distance from the proposed cable route

Figure 2-2-5 POSITION OF MAGNETIC ANOMALIES

2-2-3 Landing Site Survey

The nominated landing point (L.P) for the Submarine Cable in Madura Island is located at the coast of Bumi Anyar 4 km eastward from the fishing port of Telagabiru.

This L.P is determined by among the authorities concerned of Indonesia and the First Series Field Survey Team. A control peg was burried as a temporary base point at L.P. The Ocean Survey Team landed on shore at Bumi Anyar on 8th February and the required equipment such as a radio positioning system, an optical distance meter and transits, etc were discharged on shore. Then the team explored the area around L.P and carried out Control Point Survey.

Before the commencement of the survey for L.P, the survey vessel (KAIKO MARU No.5) was firmly secured by anchors at the bow and the stern, and then the ship's position was determined several times (taking data more than five times) using NNSS.

At the same time, the distances from the vessel to L.P and the auxiliary point were measured by using the radio positioning system. After that, the vessel's position was shifted to other point and a smilar survey was conducted. Finally, the position of L.P was determined by the trilateration method. The latitude and longitude of L.P are as follows:

Latidude (S): 06° 53.64'
Longitude (E): 113° 07.11'

The topographic features around L.P (Figure 2-2-6) are briefly given below.

The front of L.P consists of comparative flat land and the U-shape beach line. On the beach of both sides, westward and eastward, at L.P, mangrove well grows, and the land is thickly covered with various kinds of trees.
At ebb tide, the shore line goes to offshoreward up to around 600 m,

and, at flood tide, sea water comes back toward the shore near the L.P.

This tidal range is utilized for operating the fishing traps in the area around 600 m offshore. The proposed cable route crosses this area. The main road through Bangkalan runs on the land beyond L.P. The low-flat rice field is extending and small villages spreading on the both sides of the main road.

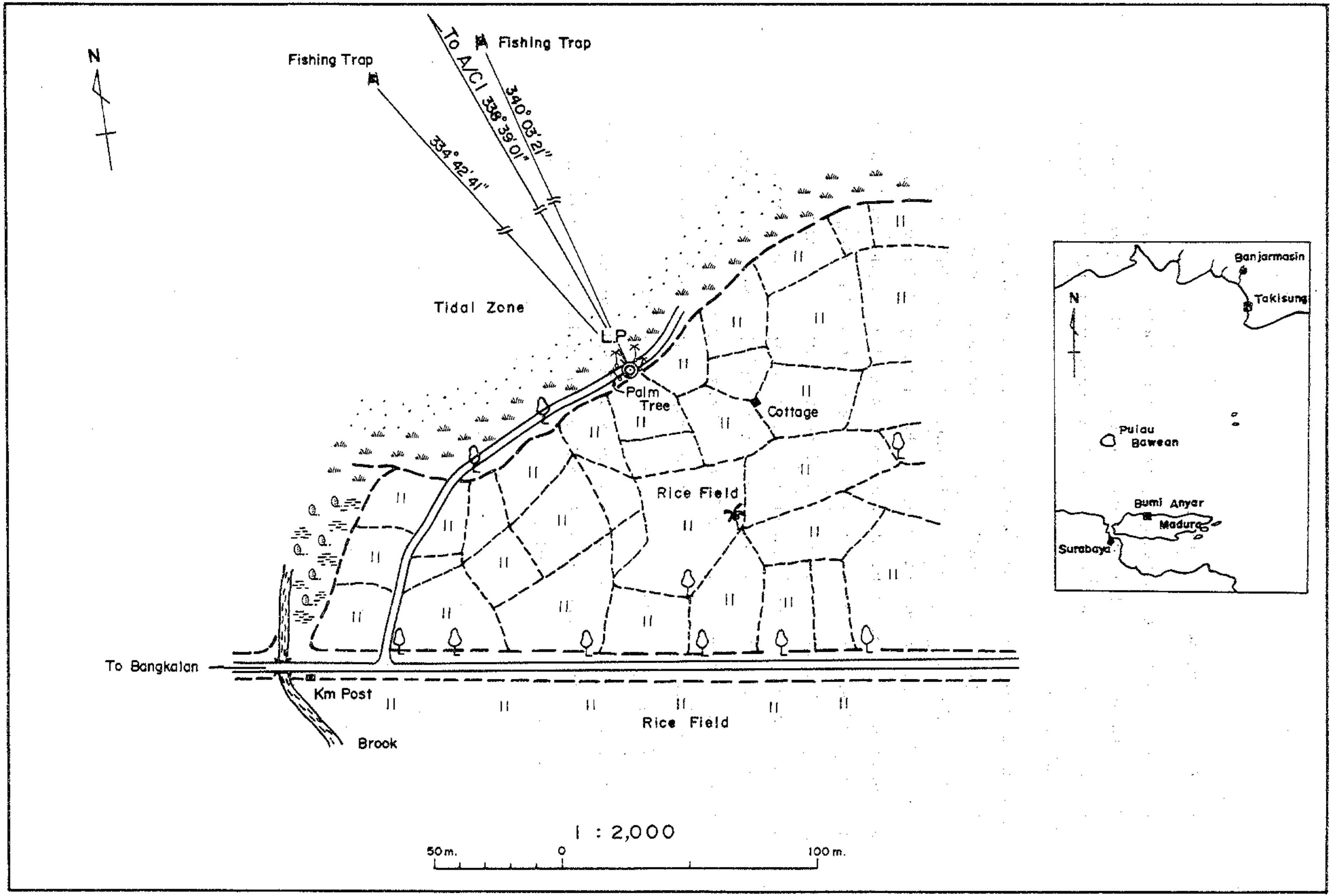


Figure 2-2-6 CABLE LANDING SITE IN BUMI ANYAR

2-2-4 Earth Resistivity Measurement

The earth specific resistivity survey was conducted on the four selected survey lines for preparing basic data of the power supply earth electrode on the beach in front of Bumi Anyar L.P on February 10th and 11th.

This survey was carried out based on the Wenner's four electrode method (ref. Appendix 3. Earth Specific Resistance Meter), and the results of the survey are shown in Table 2-2-5 and Fig. 2-2-7. Judging from the foregoing results, the earth specific resistivity on the ground surface indicated an extremely high value which is in excess of 77Ωm. The deeper the layer, the lower the value gradually. Also at the range from 5 to 11 m below the ground surface, some different stratum was found to exist. The earth specific resistivity at a deeper point (8 to 11 m below the ground surface) was estimated to be 0.88Ωm or less at No.1 line, 0.5Ωm or less at No.2 line, 0.44Ωm or less at No.3 line, and 5.0Ωm or less at No.4 line.

The earth specific resistivity on the soil tends to widely vary with each season. It is therefore desirable that this measurement be performed on a periodic basis.

Table 2-2-5 EARTH RESISTIVITY MEASUREMENT IN BUMI ANYAR

SOIL RESISTIVITY (1)

a (m)	No. 1		No. 2		No. 3		No. 4	
	R (ohm.m)	2Ra (ohm.m)	R (ohm.m)	2Ra (ohm.m)	R (ohm.m)	2Ra (ohm.m)	R (ohm.m)	2Ra (ohm.m)
0.5	24.5× 1	76.97	4.9×10	153.94	5.2×10	163.36	15.2×10	477.52
0.7	17.4× 1	76.53	3.4×10	149.54	3.6×10	158.34	7.6×10	334.27
1.0	6.4× 1	40.21	19.1× 1	120.01	2.4×10	150.80	3.6×10	226.19
1.5	3 × 1	28.27	7.5× 1	70.69	6.4× 1	60.32	17.6× 1	165.88
2.0	11.6×0.1	14.58	9.0×0.1	11.31	3.0× 1	37.70	2.3× 1	28.90
3.0	2.7×0.1	5.09	2.1×0.1	3.96	5.0×0.1	9.42	8.0×0.1	15.08
5.0	8.4×0.01	2.64	21.4×0.01	6.72	28.1×0.01	8.83	13.0×0.01	4.08
7.0	8.4×0.01	3.69	16.0×0.01	7.04	18.5×0.01	8.14	7.7×0.01	3.39
10.0	8.0×0.01	5.03	9.0×0.01	5.65	8.1×0.01	5.09	5.5×0.01	3.46
15.0	3.0×0.01	2.82	5.3×0.01	5.00	3.2×0.01	3.02	4.5×0.01	4.24
20.0	1.8×0.01	2.26	4.0×0.01	5.03	0.5×0.01	0.63	4.5×0.01	5.65
30.0	0.5×0.01	0.94	1.5×0.01	2.83				

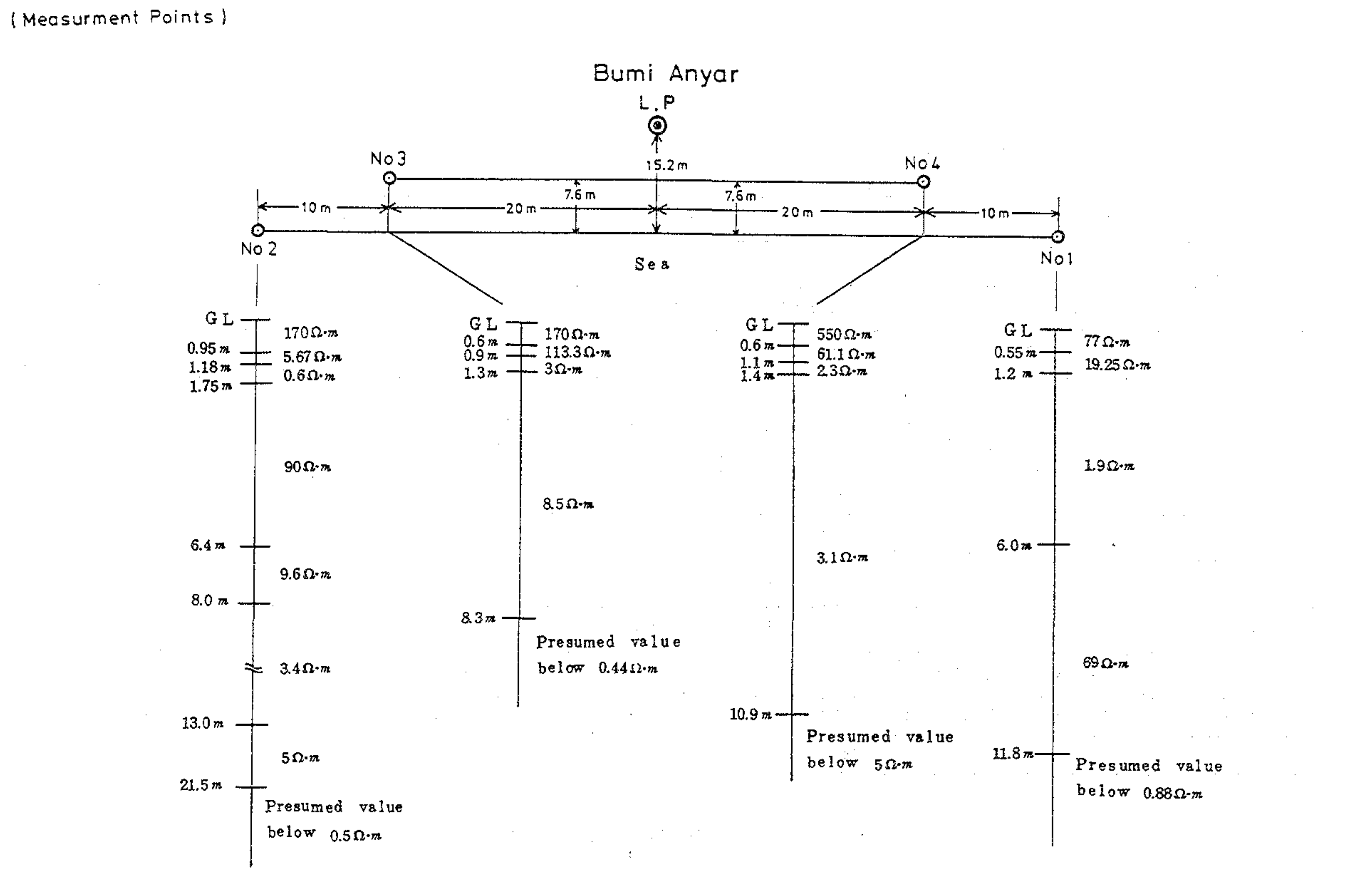


Figure 2-2-7 MEASUREMENT POINTS AND INTERPRETATION RESULTS

2-3 Takisung

2-3-1 Shallow Water Survey

The items and contents of Shallow Water Survey are summarized in Table 2-3-1 which was carried out for clarifying submarine topography and geology at the coastal area in Takisung.

Table 2-3-1 ITEMS AND CONTENTS OF SHALLOW WATER SURVEY

Survey Item	Survey Method	Objective Area
Topographic Survey	Leveling	Tidal Zone
	Echo Sounding	Area between the end of leveling area and the point 7.0 km off L.P
Side-scanning Survey	Side Scan Sonar	Area between the point 200-300 m off L.P and the point 7.0 km off L.P
Sub-bottom Survy	Driving Iron Rod	Tidal Zone
	Sub-bottom Profiler (sonoprobe)	Area same as Side-scanning area
Bottom Material Survey	Walking Survey	Area between L.P and the point 60 m off L.P
	Grab sampler	Area same as Side-scanning area
Current Observation and Water Thermometry	Aanderaa Current-meter (RCM-4)	Whole water area (Fixed Points)
	Electric thermometer (ET-5)	Whole water area (Fixed Points)

For further details, refer to "Appendix 3. Survey Equipments and Survey Methods".

The submarine topography and geology at the coastal area in Takisung are described below based on this Shallow Water Survey technique mentioned above. For the detailed results, refer to "Appendix (4. Result of Physical and Chemical Analysis for Bottom Material, 5. Oceanographic Station Data for Sampling and Deep Sea

Photographing, 10. Results of Side Scanning)", "Vol. IV Figures and Drawings (4. Coastal Survey Tracks, 5. Bathymetric and Contour Chart, 6. Bottom Profile and Sub-bottom Layers)".

(1) Submarine Topography

A general view of the topography along the proposed cable route from L.P to the end of Shallow Water Survey area, which is located 7.0 km away from L.P. is as follow.

The down-slope continues from L.P (heigh: +3.2 m) to the point 30 m off L.P, the gradient of which is 1/13. Beyond this slope, the slope changes into a more or less gentle slope. This break point of topography is +1.4 m in height. This gentle slope continues until the break point of topography is 210 m off L.P with the gradient 1/110. This break point is 0.4 m in depth. Beyond this gentle slope, any break point of topography is not recognized, and the gradient of the slope decreases little by little. The gradient of the slope becomes 1/1,000 at the end of Shallow Water Survey area, where the water depth is 9.9 m.

(2) Submarine Geology

The distribution of bottom materials is as follows. Sand is distributed near the L.P and at the tidal zone. The Sand is mainly Medium Sand, but around the foreshore, Coarse Sand with Pebbles is distributed. It is estimated that Sand is distributed until the break point of topography 210 m off the L.P. Massive and Soft Mud with shell fragments is distributed beyound this point. It is estimated that this Mud is distributed until the point 3.2 - 3.3 km off the L.P, where the water depth is about 6.0 m. The total length of the distributed area along the proposed route is about 3.0 km. Somewhat Bad-sorting and Soft Sandy Mud is distributed with shell fragments beyond the area of Mud.

The stratum of the coastal area in Takisung is divided into four layers based on the shallow seismic data. These four layers are named the first layer, the second layer, the third layer and the fourth layer in order from top to bottom.

The fourth layer has such features that the recording pattern is a fine-net pattern and that the surface of the layer is quite rough. It is estimated that the layer can be correlated with the low-grade metasedimentary rocks because of the features mentioned above and the existance of the outcrop of the low-grade metasedimentary rocks on the shore. This layer is recognized at the level of more than 6.0 m below seabed from 0.6 km to 1.6 km off the L.P on the seismic record.

The third layer can be correlated with a sedimentary layer in which bedding planes are well-developed. the surface of this layer is an erosive plane, namely, a surface of unconformity. This layer cannot be clearly traced landward from the point about 2.0 km off the L.P on the record, but it can be continuously recognized beyond this point. the surface of this layer forms a large depression which should be a part of a buried channel between the point about 2.0 km off the L.P and the point about 5.0 km off the L.P. The depth at the bottom of the depression is about 10.0 m below seabed. This layer rises to near seabed beyond the point about 5.0 km off the L.P and the depth becomes less than 1.0 m below seabed.

The second layer is correlated with a sedimentary layer which exists in such a form that the depression mentioned above is filled up. On the record, it is recognized that this layer is partially eroded. The first layer is a featureless sedimentary layer, the accumulation of which is in progress.

With the exception of the area beyond the point about 5.0 km off the L.P where the third layer rises to near seabed, it is estimated that the uppermost part of the first layer (from the seabed to about 2.0 m below seabed) shall at least be uniformly Mud and Sandy Mud because of no existence of bedding planes within this range. It is found that any rock doesn't exist at least at the tidal zone along the proposed route. Based on the results of the penetration survey by using an iron rod which is 1.5 m long, it is.

(3) Currents and Water Temperature

According to the current direction-velocity distribution (Table 2-3-2, Fig. 2-3-1) obtained from the results of 3 days contineous current observation at st.B-1 (water depth 9.8 m), direction westward, distance about 3.5 km away from Takisung L.P, the current directions at upper layer were distributed in all directions, but 43.2% of them appeared between NW and NE, and 33.5% of them appeared between SE and SW. It means that the currents at upper layer dominated in Northerly and Southerly currents. In Northerly currents, the current velocities at upper layer was 45.7 cm/s (0.9 knots, direction North) at max. and 25.8 cm/s (0.5 knots) at mean, respectively. In Southerly currents, the current velocities at upper layer was 36.8 cm/s (0.7 knots S), at max. and 26.6 cm/s (0.5 knots) at mean, respectively.

At lower layer (above seabed 1 m), the current directions distributed in all directions as well as upper layer. The 55.0% of them appeared between NW and NE, and 29.7% of them appeared between SE and SW. The most appeared direction deviated a little in comparison with upper layer. In Northerly currents, the most appeared direction was NNW (21.4%). In southerly currents, it was SSE (16.9%). As for the current velocities at lower layer, in northerly currents, max. and mean velocity were 39.3 cm/s (0.8 knots, N) and 20.0 cm/s (0.4 knots), respectively. In southerly currents, they were 24.2 cm/s (0.5 knots, SSE) and 15.8 cm/s (0.3 knots), respectively.

The current velocities at upper layer were about two times comparison with those at lower layer.

The current direction-velocity curve (Fig. 2-3-2) were drawn to determine variations in the currents. The curve suggests that the currents at upper and lower layers had a semi-diurnal period in the variation and well corresponded in N-component of currents. However, in E-component, upper and lower layer currents were not so well corresponded. It can be seen that the current at lower layer occasionally flows in the opposite direction of that at upper layer in E-Component.

The progress vector diagram (Fig. 2-3-3) suggests that the currents at upper and lower layers in this area drifted toward North with complicated variations between southerly and northerly movements.

The water thermometry at Takisung offshore was carried out at 5 stations along the cable route up to about 4.7 km off the L.P.

The results of water thermometry are shown in Table 2-3-3 and Fig. 2-3-4. According to the results, the water temperatures is in the level of 28°C from sea surface to adjacent seabed, and the structure of water temperature in this area was almost similar.

Table 2-3-2 CURRENT DIRECTION-VELOCITY DISTRIBUTION

(1)

(Direction) unit : %

Direction \ St.	B - 1 (Upper)	B - 1 (Lower)
Northernly (NW-NE)	43.2	55.0
Easterly (NE-SE)	16.3	8.0
Southernly (SE-SW)	33.5	29.7
Westerly (SW-NW)	7.0	7.3

(2)

(Velocity) unit : cm/s

Direction \ St.	Northernly		Easterly		Southernly		Westerly	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean
B-1 (Upper)	45.7 (N)	25.8	30.1 (E)	25.7	36.8 (S)	26.6	32.3 (WSW)	25.0
B-1 (Lower)	39.3 (N)	20.0	20.3 (ENE)	15.4	24.2 (SSE)	15.8	15.8 (SW)	13.2

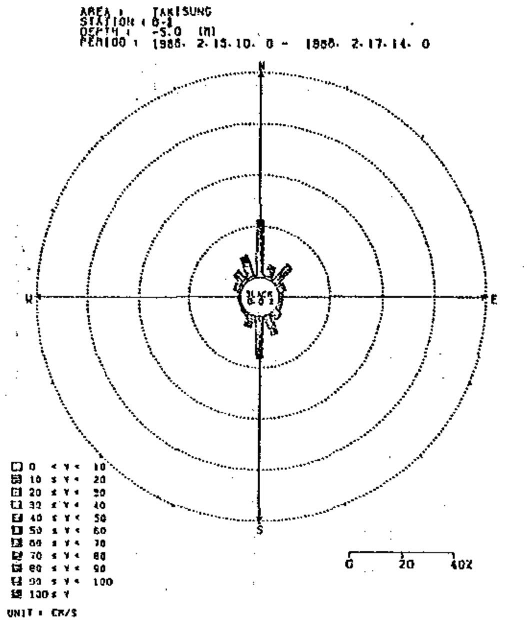
( ): The current direction at Max. Velocity appeared

Table 2-3-3 RESULTS OF WATER TEMPERATURE

Station (Depth: m)	BM 3 (1.4)	BM 4 (3.6)	BM 5 (5.2)	BM 6 (6.4)	BM 7 (7.4)
Layer \ Time	7:56~ 7:57 Feb. 17	8:11~ 8:13	8:24~ 8:26	8:35~ 8:37	8:46~ 8:48
(m)					
Sea surface -0.5	28.6	28.7	28.7	28.9	28.9
1.0		28.7	28.7	28.8	28.8
2.0		28.7	28.7	28.8	28.7
3.0			28.8	28.7	28.6
4.0			28.8	28.8	28.6
5.0				28.7	28.6
6.0					28.7
Seabed +1.0	28.6	28.8	28.8	28.7	28.7

TAKISUNG B-2 -5.0 m
1986. 2.15 10: 0 - 1986. 2.17 14: 0

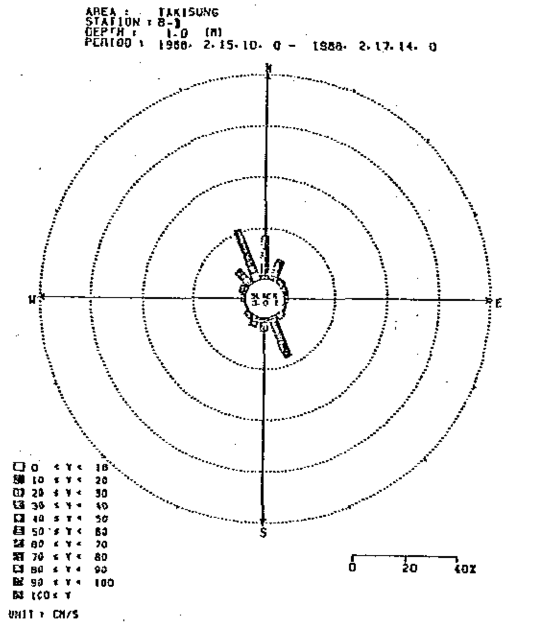
Dir. \ cm/sec	0-	10-	20-	30-	40-	50-	60-	70-	80-	90-	100-	Total
-	0 0.0											0 0.0
N	0 -	8 2.6	40 12.8	9 2.9	13 4.2	0 -	0 -	0 -	0 -	0 -	0 -	70 22.4
NNE	0 -	3 1.0	14 4.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	17 5.4
NE	0 -	1 0.3	28 8.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	29 9.3
ENE	0 -	0 -	10 3.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	10 3.2
E	0 -	0 -	5 1.6	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	6 1.9
ESE	0 -	0 -	6 1.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	6 1.9
SE	0 -	0 -	11 3.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	11 3.5
SSE	0 -	0 -	22 7.0	4 1.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	26 8.3
S	0 -	0 -	23 7.3	29 9.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	52 16.5
SSW	0 -	0 -	16 5.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	16 5.1
SW	0 -	0 -	5 1.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	5 1.6
WSW	0 -	1 0.3	1 0.3	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	3 1.0
W	0 -	1 0.3	3 1.0	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	4 1.3
WNW	0 -	3 1.0	6 1.9	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	10 3.2
NW	0 -	4 1.3	14 4.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	18 5.8
NNW	0 -	3 1.0	20 6.4	5 1.6	2 0.6	0 -	0 -	0 -	0 -	0 -	0 -	30 9.6
Total	0 -	24 7.7	224 71.6	50 16.0	15 4.8	0 -	0 -	0 -	0 -	0 -	0 -	313 100.0



Upper Layer (0.5 m under the sea surface)

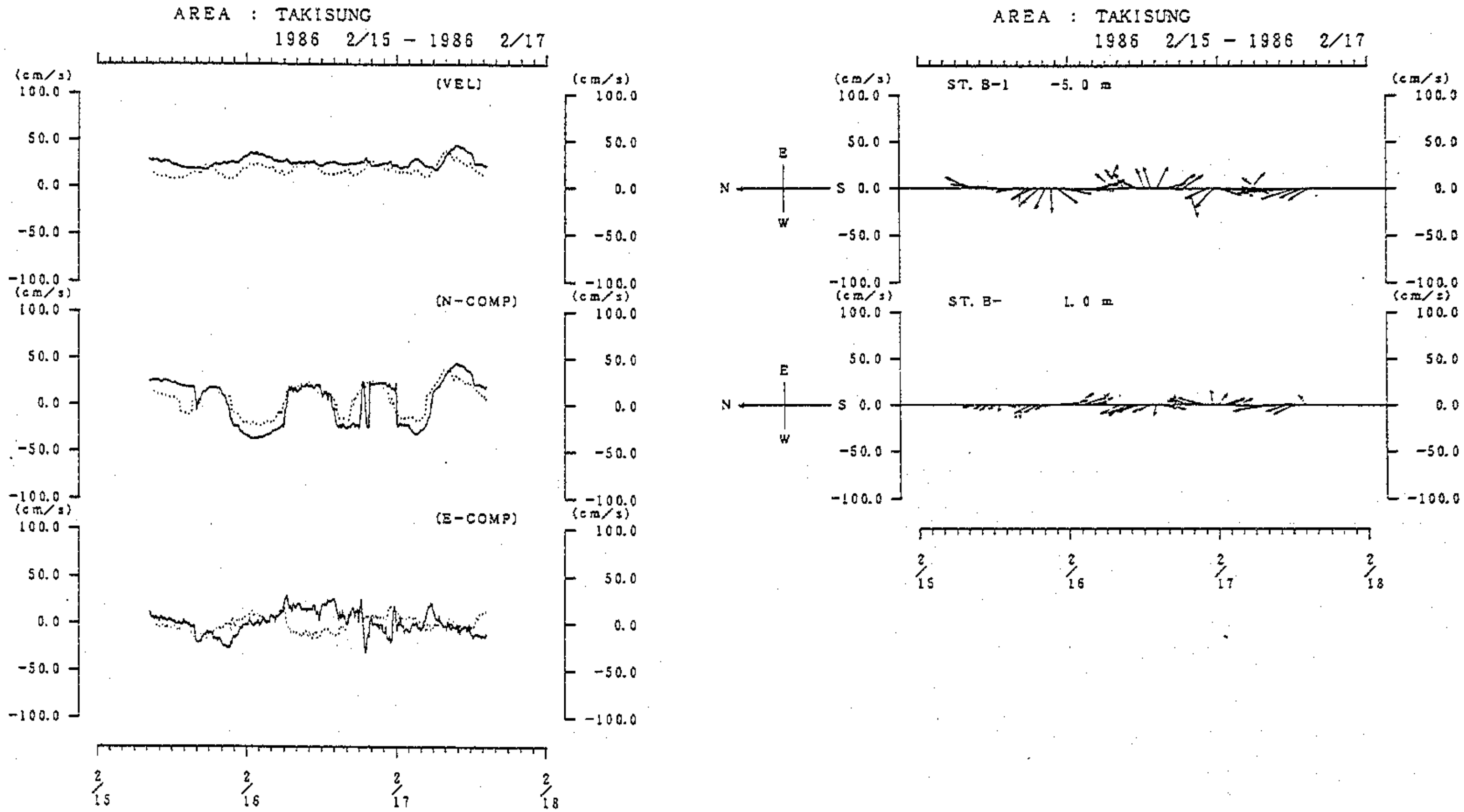
TAKISUNG B-1 1.0 m
1986. 2.15 10: 0 - 1986. 2.17 14: 0

Dir. \ cm/sec	0-	10-	20-	30-	40-	50-	60-	70-	80-	90-	100-	Total
-	0 0.0											0 0.0
N	5 1.6	14 4.5	18 5.8	17 5.4	0 -	0 -	0 -	0 -	0 -	0 -	0 -	54 17.3
NNE	0 -	13 4.2	14 4.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	27 8.6
NE	0 -	8 2.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	8 2.6
ENE	0 -	5 1.6	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	6 1.9
E	0 -	6 1.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	6 1.9
ESE	0 -	5 1.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	5 1.6
SE	0 -	8 2.6	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 2.9
SSE	3 1.0	29 9.3	21 6.7	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	53 16.9
S	2 0.6	14 4.5	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	17 5.4
SSW	3 1.0	11 3.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	14 4.5
SW	1 0.3	6 1.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	7 2.2
WSW	0 -	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	1 0.3
W	0 -	6 1.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	6 1.9
WNW	3 1.0	6 1.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	9 2.9
NW	3 1.0	13 4.2	8 2.6	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	24 7.7
NNW	11 3.5	26 8.3	29 9.3	1 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	67 21.4
Total	31 9.9	171 54.6	93 29.7	18 5.8	0 -	0 -	0 -	0 -	0 -	0 -	0 -	313 100.0



Lower Layer (1.0 m above the seabed)

Figure 2-3-1 CURRENT DIRECTION/VELOCITY FREQUENCY DISTRIBUTION AT TAKISUNG OFFSHORE



Upper Layer (5.0 m under the sea surface)
Lower Layer (1.0 m above the seabed)

Figure 2-3-2 CURRENT DIRECTION/VELOCITY CURVE AT TAKISUNG OFFSHORE
(3 DAYS CONTINIOUS OBSERVATION)

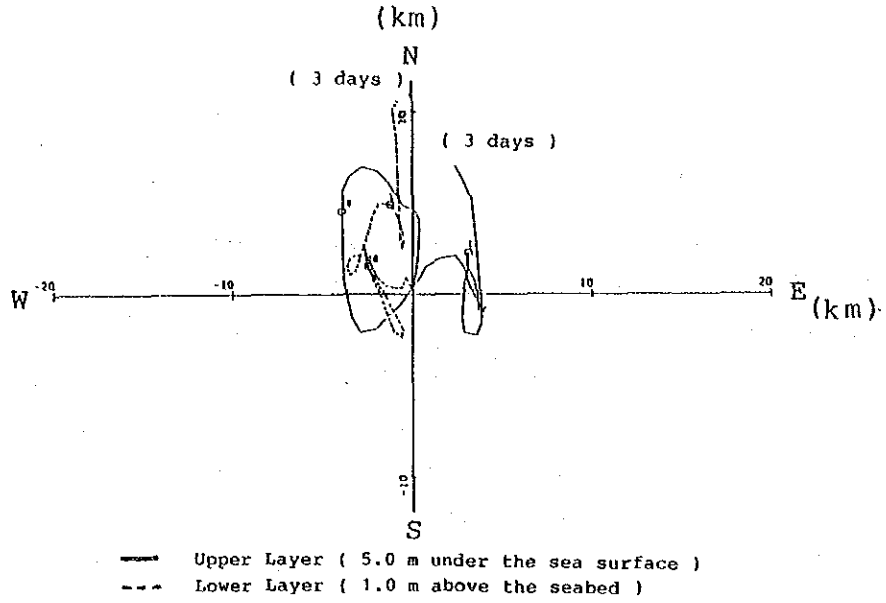


Figure 2-3-3 PROGRESSING VECTOR DIAGRAM AT TAKISUNG OFFSHORE

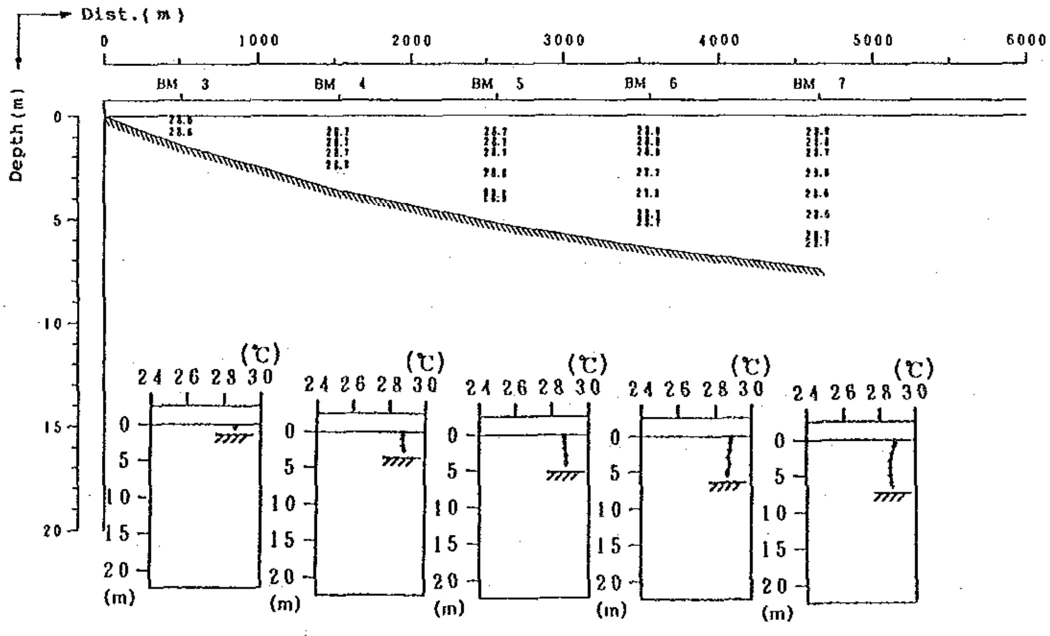


Figure 2-3-4 WATER TEMPERATURE IN EACH DEPTH AT TAKISUNG OFFSHORE

2-3-2 Landing Site Survey

The landing point (L.P) is located at the coast of Takisung which is about 63 km southward from Banjarmasin. The L.P was fully examined and determined by the First Series Field Survey Team. On February 14th, a part of the Ocean Survey Team arrived at Banjarmasin Port and brought necessary survey equipment for the coastal survey at Takisung. After arrival at Takisung, the Team was engaged in exploring the topographic features around the L.P and burried a peg for the control point at the L.P which had been selected by the First Series Field Survey Team.

The control point survey at the L.P was carried out in the same way as at Bumi Anyar. The latitude and longitude of the L.P are as follows.

Latitude(S): 03° 52.43'
Longitude(E): 114° 36.71'

The topographic features around the L.P (Figure 2-3-5) are briefly described blow.

The beach in front of the L.P extends to north and southward almost in a straight line. The beach is broaded to several meters at flood tide. Also, the beach is comparatively low and flat. At a point 250 m northward from the L.P, there is a small shallow river which serves as a mooring place for local fishing boats. Behind this area around the L.P, some marshy places are running north and southward, thick with a wide variety of trees including palm trees. There are many fish ponds, coppices and coconut plantations on major road of the land side leading to Pelahari. Houses of local peoples are scattered here and there on both sides of the main road. Topographically, this area is flat, and mostly occupied by the marsh zone.

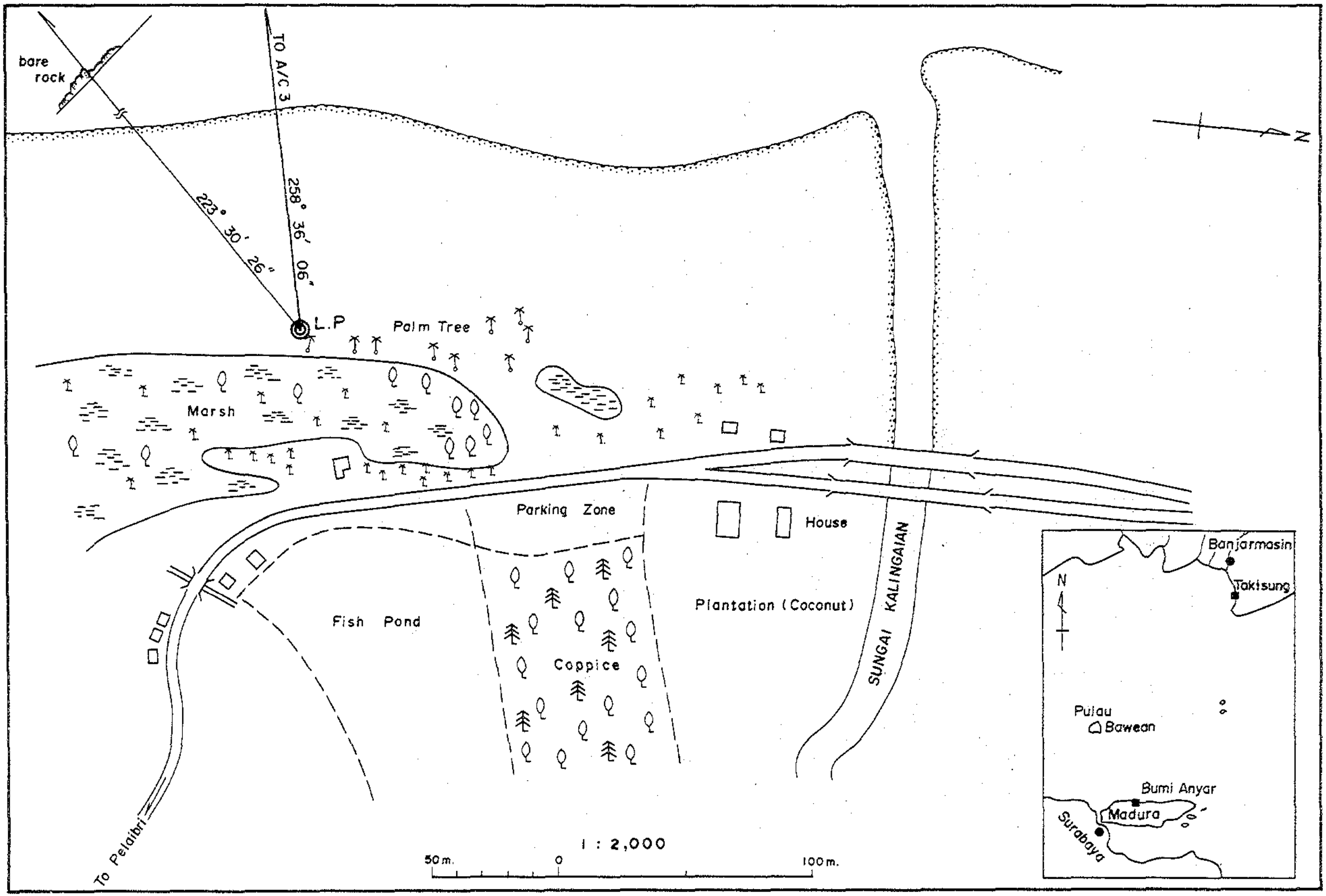


Figure 2-3-5 CABLE LANDING SITE IN TAKISUNG

2-3-3 Earth Resistivity Measurement

The earth specific resistivity survey was conducted on the four selected survey lines for preparing basic data of the power supply earth electrode on sand beach in front of Takisung L.P on February 15, 1986.

This survey was carried out based on the Wenner's four electrode method (ref. Appendix 3. Earth Specific Resistance Meter), and the results of the survey are shown in Table 2-3-4 and Figure 2-3-6. Judging from the foregoing results, the earth specific resistivity on the ground surface at this point indicated an extremely high value which was in excess of 23Ωm at No.1 survey line and 105Ωm at No.2 through No.4 survey lines. Particularly at No.3 survey line, the resistivity was as high as 6.0Ωm. Also at the range from 0.5 to 0.9 m below the ground surface, it showed still a higher value. The resistivity on No.2 and No.3 survey line suddenly indicates a low value from the level 1 m or so under the ground surface. At No.1 survey line, the resistance was less than 1.71Ωm at the level 9.4 m below the ground surface, and at No.4 survey line, it was less than 0.8Ωm at the level 14.5 m below the ground surface. Further, at No.1 and No.4 survey lines, a layer estimated to be a water layer was found to exist.

The earth specific resistivity on the soil tends to widely vary with each season. It is therefore desirable that this measurement be performed on a periodic basis.

Table 2-3-4 EARTH RESISTIVITY MEASUREMENT IN TAKISUNG

SOIL RESISTIVITY (2)

a (m)	No. 1		No. 2		No. 3		No. 4	
	R (ohm.m)	2Ra (ohm.m)	R (ohm.m)	2Ra (ohm.m)	R (ohm.m)	2Ra (ohm.m)	R (ohm.m)	2Ra (ohm.m)
0.5	3.0×10	94.25	7.0×1	21.99	3.4×10	106.81	27.4×10	860.80
0.7	10.5×1	46.18	4.7×1	20.67	20.5×1	90.16	25.5×10	1121.55
1.0	6.0×1	37.70	23.8×0.1	14.95	10.0×1	62.83	20.7×10	1300.62
1.5	3.8×1	35.81	8.3×0.1	7.82	16.9×0.1	15.93	10.0×10	942.48
2.0	2.8×0.1	35.19	3.8×0.1	4.78	4.6×0.1	5.78	4.5×10	565.49
3.0	6.0×0.1	11.31	12.1×0.01	2.28	10.0×0.01	1.88	11.5×1	216.77
5.0	12.5×0.01	3.93	2.4×0.01	0.75	3.5×0.01	1.10	5.5×0.1	17.28
7.0	3.1×0.01	1.36	1.4×0.01	0.62	2.0×0.01	0.88	2.0×0.01	0.88
10.0	3.0×0.01	1.88	1.1×0.01	0.69	1.2×0.01	0.75	0	—
15.0	1.8×0.01	1.70	0	—	0	—	0	—
20.0	0	—	0	—	0	—	0	—
30.0	0	—	0	—				

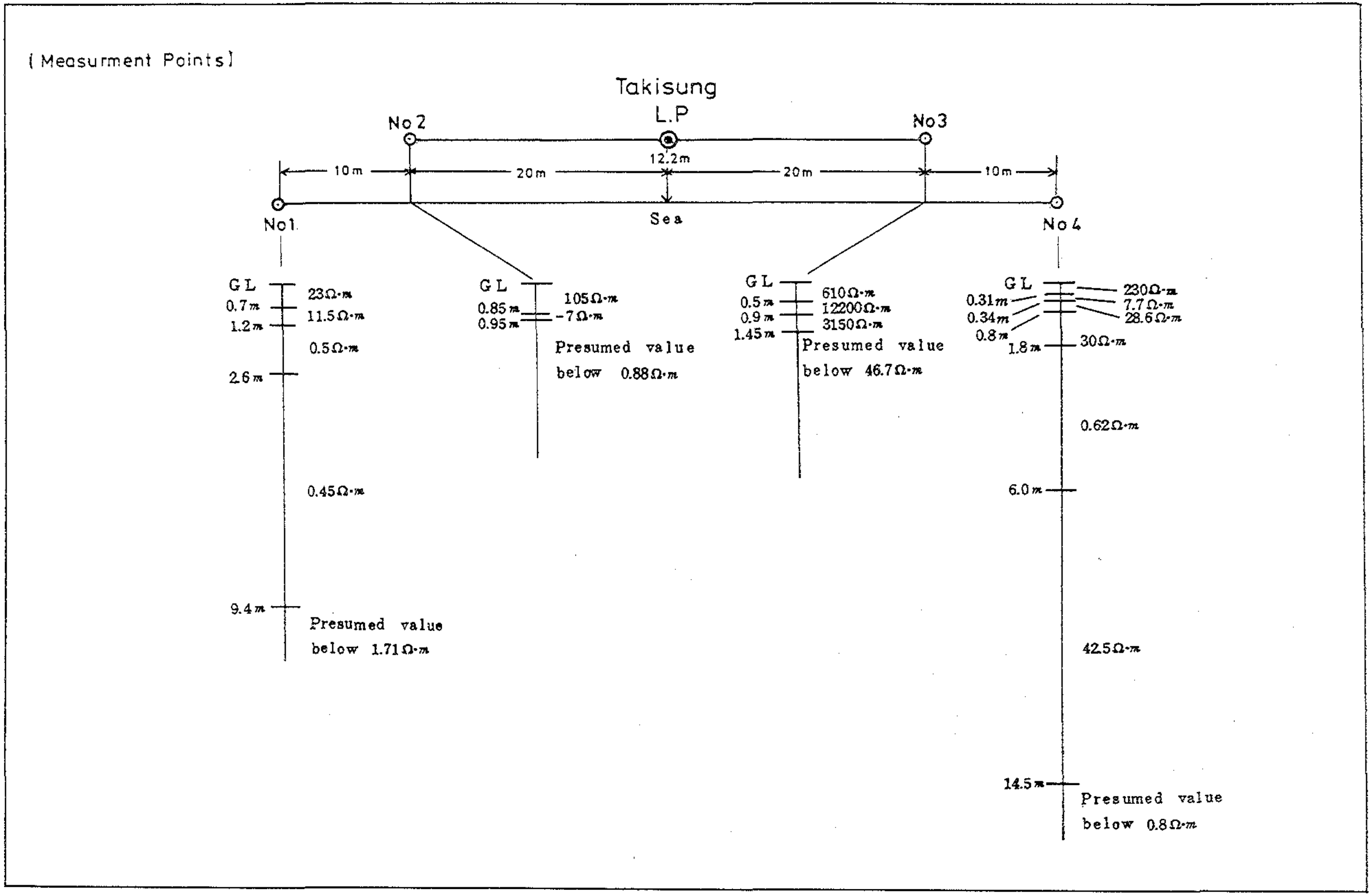


Figure 2-3-6 MEASUREMENT POINTS AND INTERPRETATION RESULTS

CHAPTER 3 OCEAN SURVEY

CHAPTER 3 OCEAN SURVEY

3-1 General

The survey route runs across in the Jawa Sea and connects between offing Bumi Anyar and offing Takisung over a total distance about 370 km. For the selection of survey route, the suficient examinations were conducted, based upon the existing nautical charts, geological data, oil development data and mine dangerous areas data etc..

The survey work were divided into the Going Run (The main survey line) and the Return Run (The sub-survey line), and carried out using a survey vessel "No.5 Kaiko Maru". The Going Run survey were carried out from February 11 to 13, 1986, and the Return Run survey was commenced as from February 18 to 20, 1986. The survey was conducted on the main survey line and sub-survey line 2 nm away from the main survey line. The survey of fixed points on the Return Run was conducted on the main survey line. As a mound with 1 m height which can be seen to be particular bottom sediment were also found in the area about 7 km away from offing Takisung, supplement survey was conducted with sounding, side scanning, and bottom samplings.

The survey items in the Going Run and the Return Run are as follows.

(1) Sounding (the Going Run, the Return Run and the supplement survey area)

(2) Sea bottom scanning (the Going Run and the supplement survey area)

(3) Seismic profiling (the Going Run)

(4) Sea bottom sampling (the Return Run and the supplement survey area)

(5) Sea bottom photographing (the Return Run)

(6) Water thermometry (the Return Run)

(7) Current observation (the Return Run)

3-2 Sea Floor

The survey conducted to determine submarine topography and geology in the ocean area is briefly as follows:

- o Topographic survey — Echo sounder
- o Side-scanning survey — Side scan sonar
- o Sub-bottom survey — Sparker
- o Bottom material survey — Piston core sampler and vibro corer

For further details, reference may be made to "Appendix 3. Survey Equipment and Survey Methods".

The submarine topography and geology which have been successfully clarified based on the results of the afore-mentioned survey are described below.

For further details of the results, refer to "Appendix (4. Result of Physical and Chemical Analysis for Bottom Material, 5. Oceanographic Station Data for Sampling and Deep Sea Photographing, 6. Bottom and Sub-Bottom Profile along Proposed Cable Route, 7. Survey Tracks, 8. Bathymetric Charts, 9. Photographs of Seabed, 10. Results of Side Scanning)", and "Vol. IV Figures and Drawings (7. Survey Tracks, 8. Bathymetric Chart, 9. Bottom Profile along the Proposed Cable Route, 10. Sub-Bottom Profile along the Proposed Cable Route)".

3-2-1 Submarine Topography

(1) Bottom Profile along the Cable Route

To observe the bottom profile along the proposed cable route, it roughly appears as below. But with regard to the submarine topography at the coastal area of Bumi Anyar and Takisung, survey results are given in 2-2-1 and 2-3-1. Incidentally, topographic section zoning is shown in Figure 3-2-1 Results for Interpretation of Submarine Topography.

a. Area from the Coastal Area of Bumi Anyar to the Deepest Point, Water Depth 77 m (95 km's Distance from the L.P)

The downward slope with a gradient of 1/320, extending from the coastal area, is extending nearly to the offing roughly with A/C 2 (about 9 km's distance from the L.P). Beyond this point, it changes to a gentle downward slope with a gradient of 1/800, and its slope continues to extend to the topographic break point with the water depth of 39 m. This topographic break point is relatively clear and is located approximately 14 km away from the L.P.

Still beyond this topographic break point, the downward slope becomes rather steep with a gradient of 1/530. This downward slope continues to the distance of 19 km from the L.P. After that, the submarine topography is almost flat. This flat plane continues to extend over the distance of approximately 45 km, ending at about 64 km's distance from the L.P. Beyond this flat plane, the slope is downward with a gradient of 1/800. This downward slope continues to extend over the distance of about 18 km, ending at about 77 km's distance from the L.P. It changes to the flat plane in the deepest water. This flat plane continues to become deeper and deeper gradually, reaching the point, water depth 77 m, whose water depth is the greatest through the survey area, while being accompanied by undulations with long wavelength.

b. Area from the Deepest Point, Water Depth 77 m to the Top of the Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P)

From the deepest point, the sea bottom becomes a upward slope with a very gentle gradient of 1/2,200 accompanied by mild undulations, reaching the topographic break point with water depth of 65 m. This topographic break point exists at about 121 km away from the L.P. Beyond this point, the sea bottom is almost flat. This flat plane continues to extend over approximately 69 km, reaching the topographic break point with the water depth of 60 m. On this flat plane, a large undulation with the relatively large ratio of difference of altitude to width is observable. When major undulations are considered, width is 900 m with a difference of altitude of 5.5 m, or width is 900 m with a difference of altitude of 3.0 m, or width is 800 m with a difference of altitude of 2.0 m. These roughly come within the range of 800 to 1,500 m in width with a difference of altitude of 2.0 to 5.5 m.

The topographic break point with the water depth of 60 m is located approximately 189 km away from the L.P. Beyond this point, there is an extremely gentle upward slope with a gradient of 1/3,400. This slope extends to the farthest point of this area (approximately 312 km away from the L.P). On this upward slope, many undulations are observable. Large undulations with width of 1 to 6 n.m and difference of altitude of 5 to 10 m and small undulations with width of 600 to 1,900 m and difference of altitude of 3 to 8 m are overlapped with each other.

c. Area from the Top of the Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P) to the Point, Water Depth 17 m offshore Takisung (about 368 km's Distance from the L.P)

When it reaches this section beyond the top, water depth 24 m, there is a large valley. This valley can be divided into two valleys by a rise nearly in the center of this area.

From the top, water depth 24 m, the slope becomes downward with a gradient of 1/1,500, reaching the bottom of first valley. The water depth of this bottom is 40 m. On this downward slope, too, some undulations were observed. These are 1,000 to 4,000 m in width, and the difference of altitude is from 3.0 to 6.5 m. From the bottom of this valley, the upward slope with a gradient of 1/700 extends to the top of the rise (approximately 347 km's distance from the L.P) mentioned above. The water depth of the top is 20 m. This upward slope also has undulations, these being 1,500 to 3,000 m in width and the difference of altitude is from 5 to 6 m.

Beyond the top of the rise, the slope becomes downward with a gradient of 1/900, reaching the bottom of second valley. The water depth of the bottom is 35 m. On this downward slope, there are undulations. Larger ones are 2,900 m in width and the difference of altitude is about 7 m. From this bottom, the slope becomes upward with a gradient of 1/500, reaching a point, water depth 17 m off the Takisung offing.

According to the nautical chart (Defense Mapping Agency, USA, No. 72060), it appears that rivers on the land, "Sungai Barito" and "Sungai Kahayan" topographically continue to extend to the sea area, and the valley of both rivers are spreading to as far as the offshore.

The above-mentioned valley is located at a point where the extention of the valley is just crossing the cable route.

d. Area from the Point, Water Depth 17 m offshore Takisung (about 368 km's Distance from the L.P) to the Coastal Area of Takisung

Beyond the point, water depth 17 m offshore Takisung, the submarine topography becomes extremely monotonous, connecting to the coastal area of Takisung on the upward slope with a gradient of 1/1,000. As described in (3) "Supplement Survey Area 7 km offshore Takisung" of this section (3-2-1), a mound was found to exist at some places.

(2) Micro-Topography

In the sea bottom along the cable route, sand waves and a large number of dimples were found to exist by the side scanning survey using a side scan sonar.

The sound waves were observed only locally through the survey area. These have the following features. Incidentally, an example of records is given in Side Scan Sonar Record No. 5 of Appendix 12.

- o Wavelength : 30 to 50 m
- o Difference of altitude : Several 10 cm
- o Direction of layout : South to North

The dimples were found almost over the entire survey area. These dimples were classified into five types according to the features. Examples of record were given in Side Scan Sonar Records No. 1 to No. 4 and No. 6 of Appendix 12.

o Type A Dimple

Shape of Plane : Round, oval, rectangular and irregular.

Size : Several tens of meters in diameter or several tens of meters in long diameter.

Difference of Altitude: Several tens of cm

o Type B Dimple

Shape of Plane : Most of them are irregular.

Size : Same as type A.

Difference of Altitude: Same as type A.

o Type C Dimple

Small dimples measuring 10 to 20 m in size densely exist. Each looks like a rice grain.

A difference of altitude is several tens of centimeters.

- o Type C' Dimple

  Small dimples measuring about 5 m in size densely exist. Each looks like a rice grain.

  A difference of altitude is several tens of 10 centimeters.

- o Type D Dimple

Shape of Plane	:	Most of them are oval.
Size	:	Max. 100 m or more in long diameter
		Max. 20 m in short diameter
Difference of Altitude	:	1.0 m or so in max.

These dimples are believed to have been created generally by spurt of natural gas.

The distribution condition of these micro-topographic features are sequentially described below, beginning with Bumi Anyar side. Incidentally, the distribution condition of micro-topographic features is shown in Figure 3-2-1.

a. <u>Area from the Coastal Area of Bumi Anyar to the Deepest Point, Water Depth 77 m (95 km's Distance from the L.P)</u>

From a point where the downward slope from the coastal area becomes flat (water depth: approximately 45 m), type A dimples is distributed over a distance of about 33 km. The distribution area belongs a flat plane whose water depth is from 45 to 57 m. Based on the number of dimples appeared on the record, the distribution density is 4 dimples/km^2. Thereafter, the dimples ceases to be recognized over the distance about 30 km, but the area changes to the flat plane at the deepest section, again beginning to show distribution of dimples.

The dimples distributed here are type B. The distribution density is 5 dimples/km^2. The water depth of the distribution is roughly

72 to 77 m.

b. Area from the Deepest Point, Water Depth 77 m, to the Top of Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P)

In this section, type B dimple is basically distributed with the exception of some part. On the upward slope with a gradient of 1/2,200 from the deepest point, type B dimples are distributed at the density of 5 pieces/km^2. There are type C dimples in existence halfway from the upward slope.

Also on a flat plane which continues to extend over a distance of about 69 km, type B dimples are distributed, but the distribution density tends to vary at a point 1/3 this flat plane. In the range of first 1/3, the distribution density is 5 pcs./km^2 and in the range of last 2/3, it is 20 pcs./km^2. Type C' dimples exist near the end of this flat plane.

On an extremely gentle upward slope with a gradient of 1/3,400 continuing from the above flat plane, type B dimples are distributed over a slope range of up to 7/10 or so. In a range of first 2/5 of the distribution area, distribution density is 20 pcs./km^2 in a range of 2/5 to 9/10 of the distribution area, distribution density is 1 to 7 pcs./km^2; in a range up to the last from 9/10 of the distribution area, distribution density is 21 pcs./km^2. These are extremely variable. For a while thereafter (the distance of about 9 km), dimples cease to be recognized. Next, the sand wave distribution area continues to extend over the distance of about 3.5 km. Again, type B dimples began to be recognized, attaining distribution up to the end of the upward slope. The distribution density of this area is about 7 pcs./km^2.

c. Area from the Top of the Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P) to the Point, Water Depth 17 m, offshore Takisung (about 368 km's Distance from the L.P)

Almost from the beginning of this area through the halfway of the downward slope to the first Valley Bottom (Approximately 8 km long), type D dimples are distributed. Each of these dimples presents a oval shape, and the direction of the apse line is between N-S and SSW-NNE. From the end of this area to the halfway of the slope with a gradient of 1/500 beyond the 1st valley bottom and the 2nd valley bottom, type B dimples are again distributed. The distribution density is mostly 35 pcs./km^2, but at a place near the end of this range, it is 12 pcs./km^2. In a range from the halfway of this upward slope to the point, water depth 17 m offshore Takisung, no dimples were observable.

d. Area from the Point, Water Depth 17 m offshore Takisung (about 368 km's Distance from the L.P) to the Coastal Area of Takisung

In this area, no micro-topographic features such as dimples could be observed.

(3) Supplement Survey Area 7 km offshore Takisung

At st.0-3 located about 7 km offshore Takisung, a sampling was conducted by the piston core sampler. As a result, the core length as little as 6 cm could be sampled. So, the possibility of exposed rocks are anticipated in the vicinity of st.0-3, and for this reason, the echo sounding and the side scanning survey was additionally conducted. The supplement survey area is located on the mild slope with a gradient of 1/1,000 in the Area from the Point, Water Depth 17 m offshare Takisung to the Coastal Area of Takisung, and the area is about 2 x 4 km in size. As a result of the survey, the survey tracks and the bathymetric chart is shown in Figure 3-2-2 and 3-2-3.

As a result, a mound with the base of 800 to 1,000 m and the difference of altitude of about 1.5 m was found nearly in the center of the area. Unlike others, this mound shows a black tone on the record. It indicates that the seabed is rather coarser than others. There were no records indicating the existence of exposed rocks.

After executing the auxiliary work of echo sounding and side scanning survey, the sampling was conducted by using a vibro corer in confirmation of the bottom material and sub-bottom layer, as described in 3.2.2 below. As a result, a 3.2 m long core sample was obtained. So, under the sandy sediments, several cm in thickness, the existence of a compact and viscous white clay layer was found. The sub-bottom survey result by Sparker indicates that the 3rd layer (3.2.2) which is widely spread over the ocean survey area comes up to nearly the seabed in this area, and that the white clay layer could be correlated with this 3rd layer.

Therefore, the mound which was found to exist as a result of the supplement survey presumably result from the undulation of the 3rd layer.

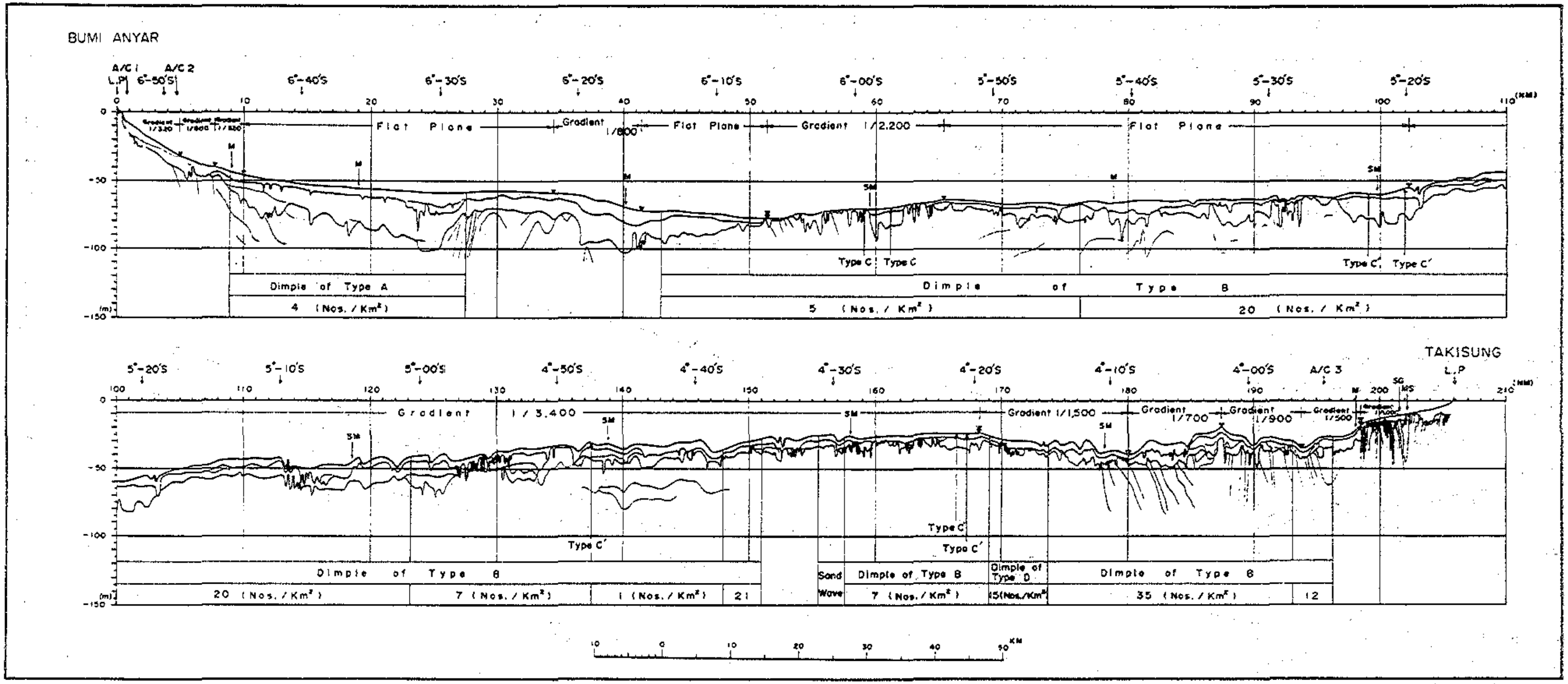


Figure 3-2-1 RESULTS FOR INTERPRETATION OF SUBMARINE TOPOGRAPHY

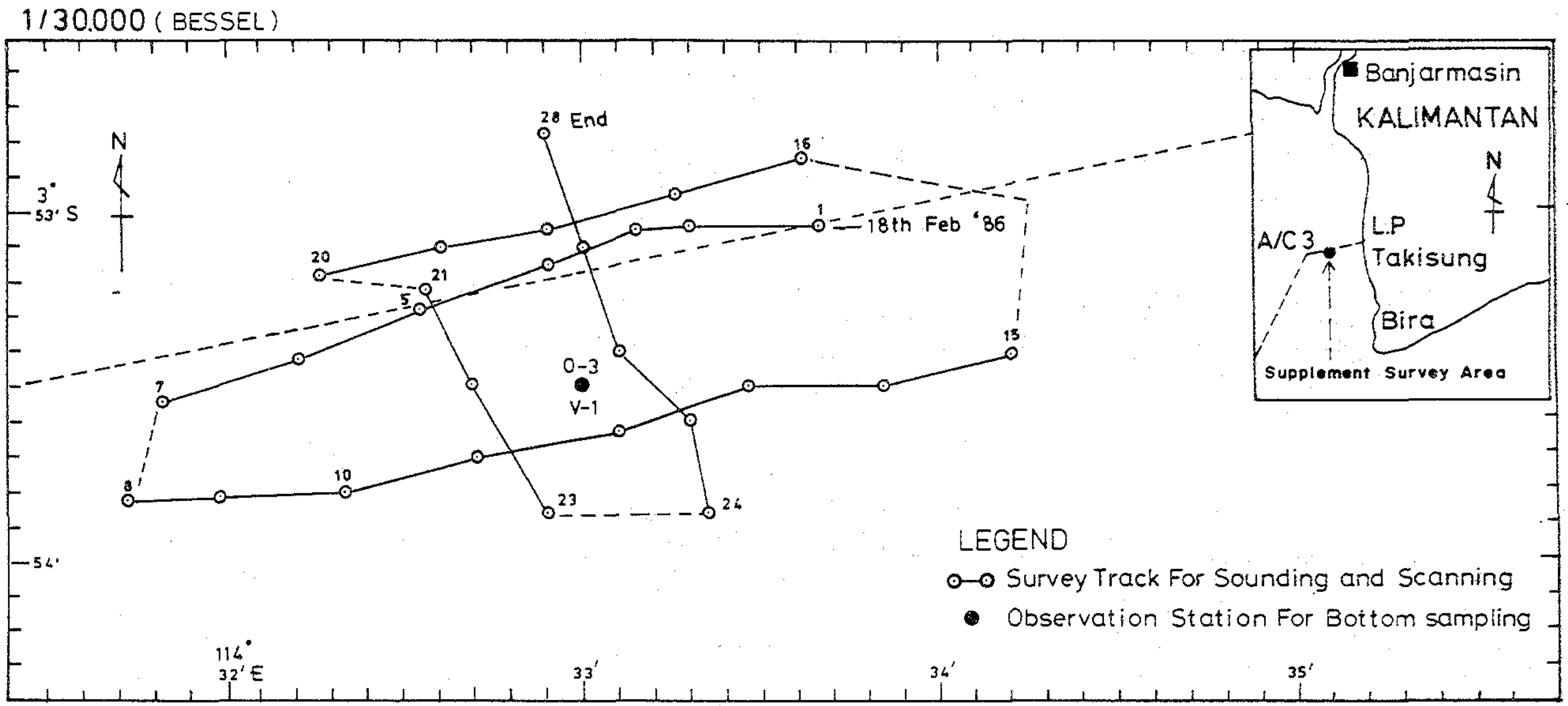


Figure 3-2-2 SURVEY TRACKS ON SUPPLEMENT SURVEY (7 km OFF TAKISUNG SHORE LINE)

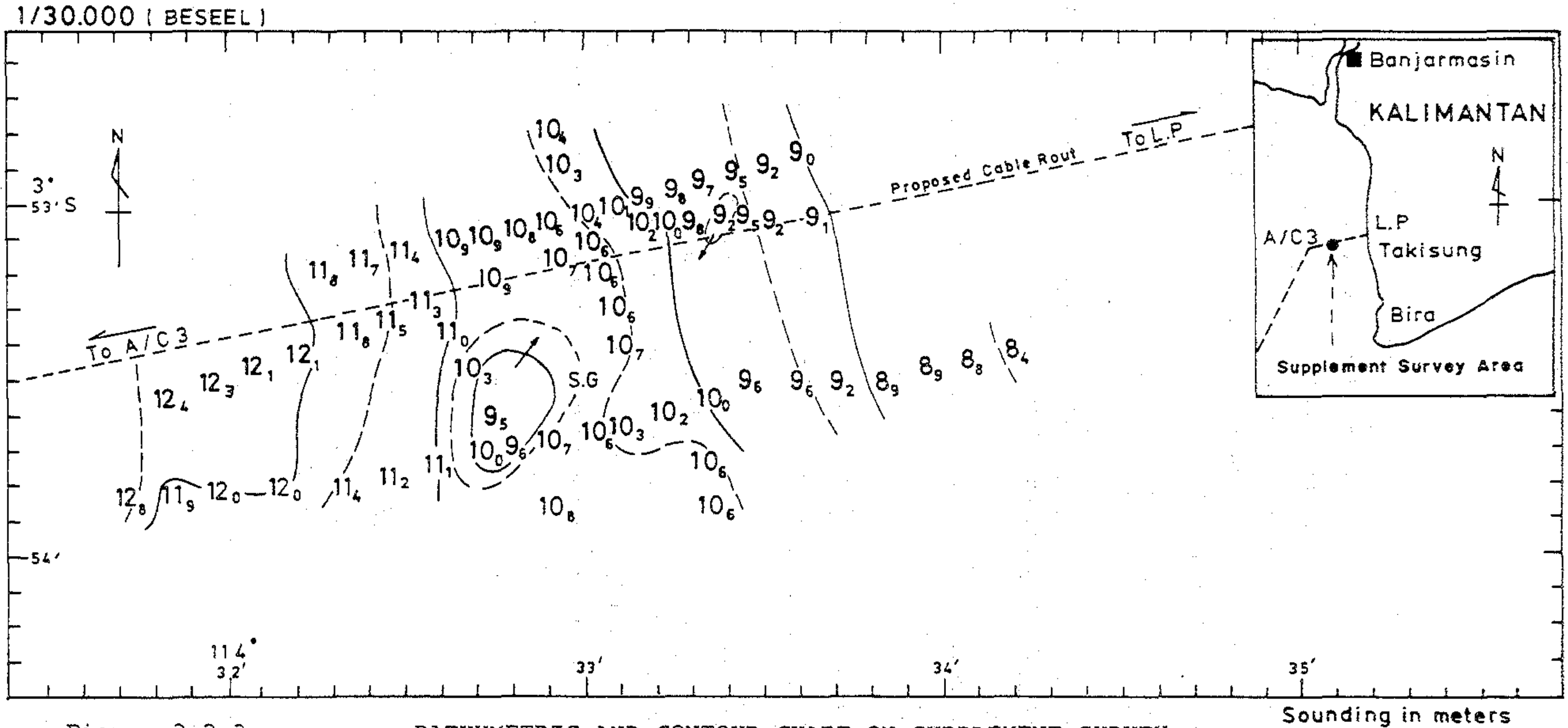


Figure 3-2-3 BATHYMETRIC AND CONTOUR CHART ON SUPPLEMENT SURVEY
(7 Km OFF TAKISUNG SHORE LINE)

3-2-2 Submarine Geology

To roughly observe the distributed bottom materials on the sea bottom surface along the proposed cable route and the geology below the seabed, it appears as follows. But for the submarine geology on the coastal areas of Bumi Anyar and Takisung, the report is given in 2-2-1 and 2-3-1, respectively.

(1) Bottom Materials on the Seabed Surface

a. Area from the Coastal Area of Bumi Anyar to the Deepest Point, Water Depth 77 m (95 km's Distance from the L.P)

In this area, Mud containing several per cent of Sand is uniformly distributed.

b. Area from Deepest Point, Water Depth 77 m to the Top of the Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P)

There are six sampling points in this area, of which five such points are of Muddy Sand, and one point is of Mud. Therefore, the major distributed bottom materials in this area can be said Muddy Sand. Particularly in and around the Sand Wave growing area, a record indicating the presence of coarse grain sediments has been obtained by the side scan sonar. It is believed that the bottom materials in this area is relatively coarse as compared with that in other areas.

c. Area from the Top of the Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P) to the Point, Water Depth 17 m offshore Takisung (about 368 km's Distance from the L.P)

There are two sampling points in this area, of which one point is of Muddy Sand and the other is Mud. Because of topographic similarity to the above area, the major distributed bottom materials in this area is also of Muddy Sand. At the rise in the center sandwitched between two valleys, the record indicating the existence of coarse sediments has been obtained by the side scan sonar. It is therefore believed that the bottom materials coarser than that in other areas would be distributed.

d. Area from the Point, Water Depth 17 m offshore Takisung (about 368 km's Distance from the L.P) to the Coastal Area of Takisung

There are two sampling points in this area, of which one point is of Sandy Mud and the other is of Pebbly Sand. Because the submarine topography in this area is relatively monotonuous, major distributed bottom materials here is assumed to be Sandy Mud.

(2) Geology below Seabed

As a result of analysis of the Sparker record, it was found that the geological layers in the area of ocean survey could be broadly classified into three. From the top to bottom, these are named the 1st layer, 2nd layer and 3rd layer. These layers are sequentially described as from the lowest layer.

Within the 3rd layer, bedding planes are extremely well grown here and there. The surface of this layer is obviously a surface of unconformity surface subjected to erosion. At a point 7 km off the Takisung offing where this layer comes up to the seabed surface, it was sampled by means of a vibro corer. The layer that could be sampled here is, for the most part, compact and viscous white clay layer. In part, this is an alternation of clay layer and sandy layer. Judging from the foregoing, this layer could be assumed as belonging to Pleistocene Series.

The 2nd layer is a layer where sediments are banked up in the depression formed by the surface of the 3rd layer. The sedimentary facies of the 2nd layer is assumed to be mainly a clay layer for the reasons that the clay layer that could be assumed to be the 2nd layer was obtained at st.0-4 and that the growth of the bedding plane is not so good. The surface of this layer is subjected to erosion just as in the case of the 3rd layer, thereby presenting a topographic appearance of valley at many places. So, judging from this too, it is highly probable that this layer belongs to Pleistocene Series.

From the results of soil sampling using a piston corer, it could be assumed that the 1st layer is a sediment layer mainly consisting of mud, sandy mud, muddy sand, and sand. It would therefore belong to the Recent Series.

Next, the change of thickness for the 1st layer by area is described according to the topographic classification made in 3-2-1, because it is important for the cable laying.

a. Area from the Coastal Area of Bumi Anyar to the Deepest Point, Water Depth 77 m (95 km's Distance from the L.P)

As compared with other area, the 1st layer is thick as a whole. Roughly speaking, it is about 10 to 15 m at thick points and 4 to 5 m at thin points.

b. Area from the Deepest Point, Water Depth 77 m to the Top of the Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P)

The layer thickness in this area, it is about 10 m at thick points and 1 m or less at thin points. Where the layer thickness is less than 1 m are as below:

- o Area where a upward slope with a gradient of 1/2,200 exists between the deepest point, water depth 77 m and the topographic break point, water depth 65 m.
- o A part of the flat plane from the topographic break point, water depth 65 m, to next topographic break point, water depth 60 m (approximately 175 km away from the L.P).
- o A part of the upward slope with a gradient of 1/3,400 from the topographic break point, water depth 60 m, to the top of the upward slope, water depth 24 m (approximately 250 km away from the L.P).

c. Area from the Top of the Upward Slope, Water Depth 24 m (about 312 km's Distance from the L.P) to the Point, Water Depth 17 m offshore Takisung (about 368 km's Distance from that L.P)

The thickness of the layer in this area is roughly 7 m or so at thick points and 2 m or so at thin points.

d. Area from the Point, Water Depth 17 m offshore Takisung (about 368 km's Distance from the L.P) to the Coastal Area of Takisung

The thickness of the layer in this area is roughly 10 m or so at thick points and 1 m or less at thin points. Where the layer thickness is 1 m or less exists at two points, namely, near the beginning of this area and near the center of this water area (in the vicinity of the supplement survey area).

3-3 Currents and Water Temperature

The current observations and water thermometry in the ocean area were carried out at 11 stations along the cable route between st.0-2 (direction WSW, at a distance, of about 14 km off the Takisung L.P) and st.0-13 (direction Northward, at a distance of about 14.5 km off the Bumi Anyar L.P) over a total distance of about 333.5 km.

The results of current observation in the ocean area are shown in Table 3-3-1, Fig. 3-3-1. Those stations were separated into three small areas every 1° in latitude and named the Northern area, Mid-area and Southern area, respectively.

In the Northern area for 4 stations (st.0-2,4,5 and 6) adjacent to Takisung, the current directions at upper layer had the tendency of South-easterly streams. The max. current velocity at upper layer was 27.5 cm/s (0.5 knots, direction SE) at st.0-4, and also the mean current velocity was 23.1 cm/s (0.4 knots) in the Northern area.

The appeared current directions at lower layer differed from that at upper layer with some deviation among each station in the Northern area. The max. current velocity at lower layer was 20 cm/s (0.4 knots, SSE) which was observed at st.0-6, and also the mean velocity was 16.0 cm/s (0.3 knots) in the Northern area.

In Mid-area for 4 stations (st.0-7,8,9, and 10), the current directions at upper layer were generally southeasterly.
The current velocity at upper layer became larger, as the station shifted to south along the cable route. Max. and mean velocity at upper layer were 53.0 cm/s (1 knot, SE) at st.0-10 and 33.0 cm/s (0.6 knots), respectively.

The current directions at lower layer in the Mid-area were generally easterly, except at st.0-8. Max. and mean velocity at lower layer were 18.3 cm/s (0.4 knots, NNW) at st.0-8 and 14.3 cm/s (0.3 knots), respectively.

In the Southern area for 3 stations (st.0-11,12, and 13), the current directions at upper layer were generally easterly. The current directions at lower layer were easterly at st.0-11, and westerly at st.0-12 and st.0-13 adjacent to Bumi Anyar with reversing direction against upper layer.

As for the current velocities, velocity 65.9 cm/s (1.3 knots, ESE) at upper layer at st.0-12 was max. value in the Southern area. This value was also max. through all stations in the ocean area. The mean velocity at upper layer was 61.3 cm/s (1.2 knots). The max. current velocity at lower layer was 25.9 cm/s (0.5 knots, SW) which was observed at st.0-13, and also the mean velocity was 21.8 cm/s (0.4 knots).

To consider the current directions on the cable route from a standpoint of the entire ocean area, these directions at upper layer were generally easterly. The current velocities at upper layer were higher in Southern area than in Northern and Mid-area.

The current directions at lower layer reversed and deviated as compared with the directions at upper layer at times. The difference between the current velocities at lower layer through the ocean area could be hardly found.

The results of water thermometry in the ocean area are shown in Table 3-3-2 and Fig. 3-3-2.

According to the water temperature profile in the ocean area, the water temperature was the level of 28°C in the area from Takisung offshore to st.0-6, and at st.0-8, st.0-9 in the Mid-ocean. The water temperature at st.0-7 in the Mid-ocean area and in the area adjacent to Takisung was the level of 27°C.

To consider the vertical variations of water temperatures, the difference of water temperature between upper layer and lower layer could be hardly found at each station. Even if the deepest station at st.0-10 (Water depth 70.6 m), the range of the difference of water temperature was only 0.4°C°.

The followings were concluded regarding water temperatures in the ocean area.

The level of 28°C more or less was spreaded in the ocean area from upper layer to lower layer, but a little higher water temperature was observed in the Northern area adjacent to Takisung and in the Mid-ocean area.

Table 3-3-1 RESULTS OF CURRENT OBSERVATION IN THE OCEAN AREA

Station	Latitude (S)	Longitude (E)	Depth (m)	Date	Observed Time	Upper Layer (-5.0m) Vel. (cm/s)	Upper Layer (-5.0m) Dir. (Deg.)	Lower Layer (B+3.0m) Vel. (cm/s)	Lower Layer (B+3.0m) Dir. (Deg.)
O - 2	3°53.96'	114°29.23'	21.6	Feb.18	6 - 30	27.0	109°	13.0	358°
O - 4	4°10.50'	114°19.40'	37.5	Feb.18	17 - 30	27.5	142°	17.5	198°
O - 5	4°28.75'	114°11.26'	26.1	Feb.18	22 - 00	17.2	46°	13.5	276°
O - 6	4°46.55'	114°02.93'	32.3	Feb.19	2 - 00	20.8	135°	20.0	159°
O - 7	5°04.76'	113°54.62'	45.1	Feb.19	6 - 10	24.7	130°	13.3	63°
O - 8	5°22.08'	113°46.45'	59.4	Feb.19	10 - 20	21.9	70°	18.3	332°
O - 9	5°41.10'	113°38.00'	65.7	Feb.19	15 - 10	32.3	119°	8.5	22°
O -10	5°58.92'	113°30.21'	70.6	Feb.19	19 - 00	53.0	126°	16.9	83°
O -11	6°16.66'	113°22.21'	70.0	Feb.20	6 - 40	52.7	89°	17.2	71°
O -12	6°35.90'	113°13.00'	56.1	Feb.20	11 - 10	65.9	107°	22.2	261°
O -13	6°45.06'	113°08.85'	44.0	Feb.20	14 - 40	65.3	86°	25.9	237°

Maximum Velocity	Upper Layer :	65.9 cm/s, 107° at St. O - 12
	Lower Layer :	25.9 cm/s, 237° at St. O - 13
Mean Velocity	Upper Layer :	37.1 cm/s
	Lower Layer :	16.9 cm/s
Remarks :	Upper Layer	5.0 m under the sea surface
	Lower Layer	3.0 m above the seabed

Table 3-3-2 WATER TEMPERATURE IN OCEAN AREA

Station (Depth : m)	O- 2 (21.6)	O- 4 (37.5)	O- 5 (26.1)	O- 6 (32.3)	O- 7 (45.1)	O- 8 (59.4)	O- 9 (65.7)	O-10 (70.6)	O-11 (70.0)	O-12 (56.1)	O-13 (44.0)
Layer \ Time	6:22~ 6:24 Feb. 18	16:56~ 16:59	22:00~ 22:05	1:30~ 1:35 Feb. 19	5:50~ 5:53	10:28~ 10:32	14:58~ 15:02	19:20~ 19:24	6:15~ 6:19 Feb. 20	11:10~ 11:15	14:23~ 14:26
Sea surface (m) -0.5	28.4	28.8	28.4	28.0	27.9	28.3	28.0	27.9	27.7	27.8	27.8
1.0	28.4	28.9	28.4	28.0	27.9	28.2	28.0	27.8	27.7	27.8	27.8
2.0	28.4	28.9	28.4	28.0	27.9	28.2	28.0	27.8	27.7	27.7	27.8
3.0	28.4	28.9	28.4	28.0	27.9	28.2	28.0	27.8	27.7	27.7	27.8
4.0	28.4	28.8	28.4	28.0	27.9	28.2	28.0	27.8	27.7	27.7	27.8
5.0	28.4	28.8	28.5	28.0	27.9	28.2	28.0	27.8	27.7	27.7	27.8
6.0	28.5	28.8	28.4	28.0	27.9	28.2	28.0	27.8	27.7	27.7	27.8
7.0	28.5	28.9	28.4	28.0	27.9	28.2	28.0	27.8	27.7	27.7	27.8
8.0	28.5	28.9	28.4	28.0	27.9	28.2	28.0	27.8	27.7	27.7	27.8
9.0	28.6	28.8	28.4	28.0	27.9	28.1	28.0	27.8	27.7	27.7	27.8
10.0	28.6	28.6	28.4	27.9	27.9	28.1	28.0	27.8	27.7	27.7	27.8
20.0	28.6	28.2	28.3	27.9	27.9	28.0	28.0	27.8	27.7	27.7	27.7
30.0		28.0		27.9	27.9	28.0	27.9	27.7	27.7	27.6	27.7
40.0					27.9	28.0	27.9	27.7	27.7	27.6	27.5
50.0						27.9	27.8	27.7	27.7	27.6	
60.0							27.8	27.6	27.7		
Seabed+1.0	28.6	28.0	28.2	27.9	27.9	27.9	27.4	27.5	27.6	27.0	27.1

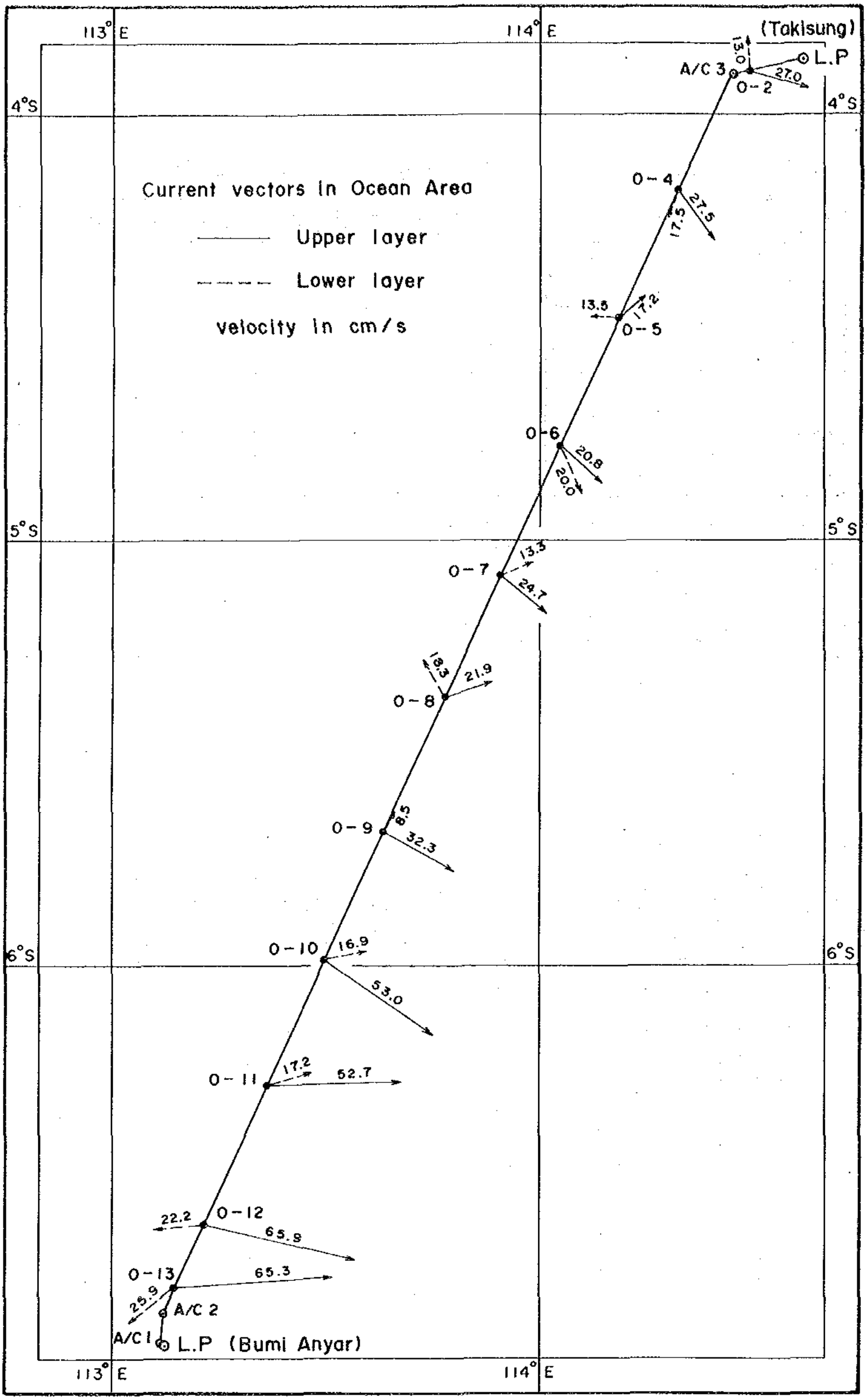


Figure 3-3-1 CURRENT DIRECTION VECTOR IN OCEAN AREA

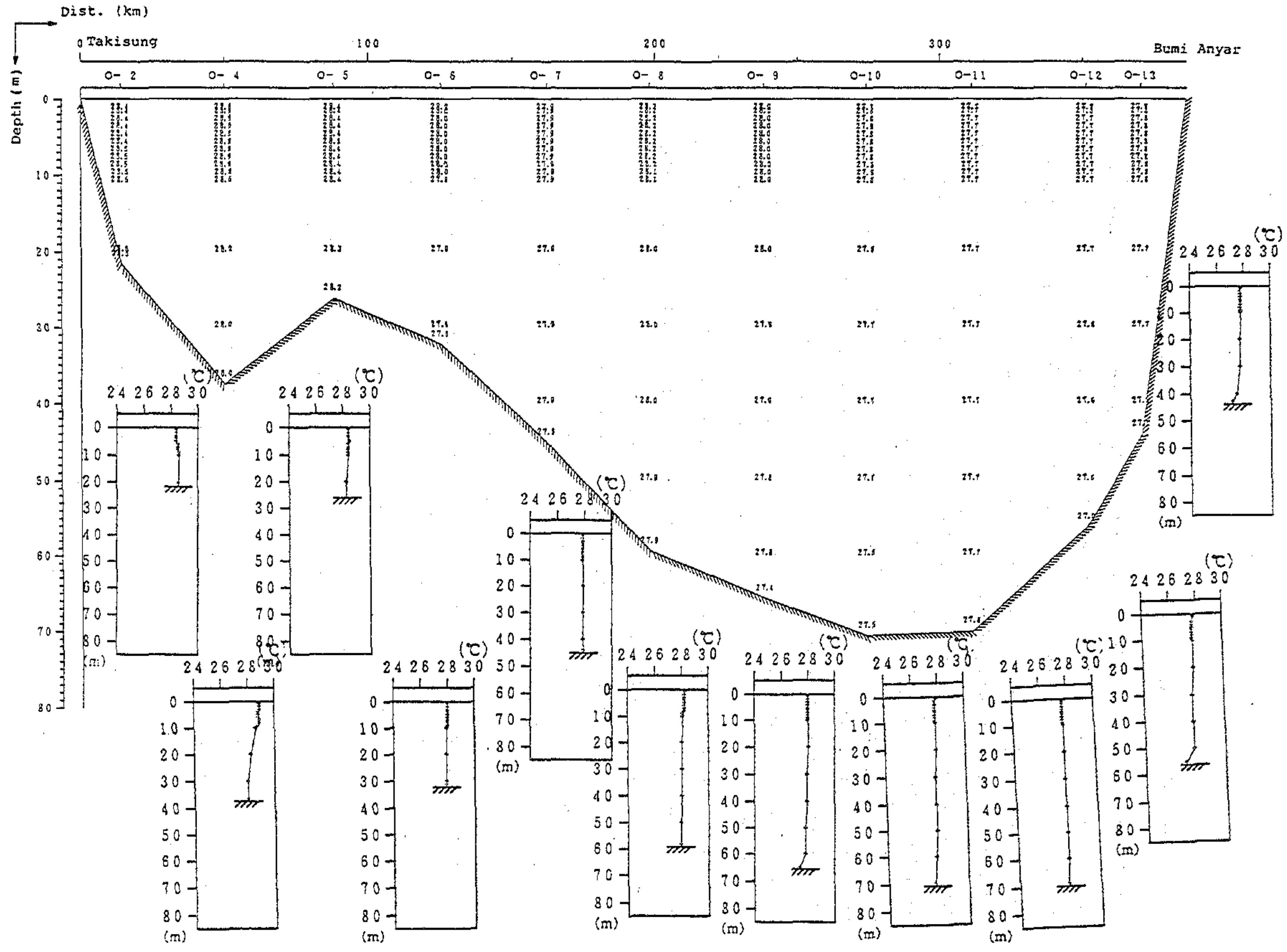


Figure 3-3-2 WATER TEMPERATURE IN VERTICAL VARIANCE AND PROFILE AT OCEAN AREA

3-4 Vessel's Position Fixing

The ocean area to be surveyed belongs to the Jawa Sea where extends from Madura Island (Bumi Anyar) to Kalimantan (Takisung) over a total distance of about 380 km. The charts for survey were prepared based on Mercator's Projection (standard parallel of latitude 5° 30' S) using the constant values (Vessel's ellipsoid) just as in the case of constant values in Indonesian charts. The shore lines and markable targets which are shown in the Indonesian charts were adoped and drewn into the survey charts. The positioning of ship were determined using NNSS and Omega System. However, the positioning values obtained by afore-mentioned navigation systems have to be converted into the Indonesian Geodetic System because the values are based on WGS-72 (World Geodetic System 1972). The conversion values were calculated using the constant values at Batavia (The old name of Jakarta) control point. The results are shown in Fig. 3-4-1. The results of converted value from WGS-72 to the Indonesian Geodetic System tends to show large deviations (68 m deviation NW ward) on the side of Madura Island and small deviations (47 m deviation NW ward) on the side of Kalimantan Island.

During the survey in the ocean area, vessel's position fixings adopted Hybrid Navigation System combined NNSS and Omega Navigation System. The Hybrid Navigation System is a method of obtaining the position in combination with two navigation systems.

The accuracy of positioning by Omega System is inferior to NNSS in mono-operation, but Omega System can obtain positions continously in a marked character. The ship's position fixing was carried out with the availability of this marked character aforementioned together with combination of NNSS (accuracy: 0.1 mile at ship in rest and 0.2 to 0.5 miles in ship undergoing).

However, the Omega electronic wave was sometimes disturbed in the case that the state of ionosphere fluctuates, because this wave propagates between the ionosphere and the earth.

In such cases, the ship's positions were examined continuously in way of the dead reckoning navigation using gyrocompass and ship'log until the next position fixing by NNSS. The positionings in offshore area were examined by using the radar with bearing and distance of land mark from vessel together with positions obtained by NNSS. The position error between the radar and NNSS was small and the positionings offshore area were determined with sufficient accuracy.

According to the condition of satelite orbits (Appendix 11), a mean interval of satellite orbit was about 80 min. for good accuracy positioning obtained in the survey area between 4°(S) and 7°(S) in latitude.

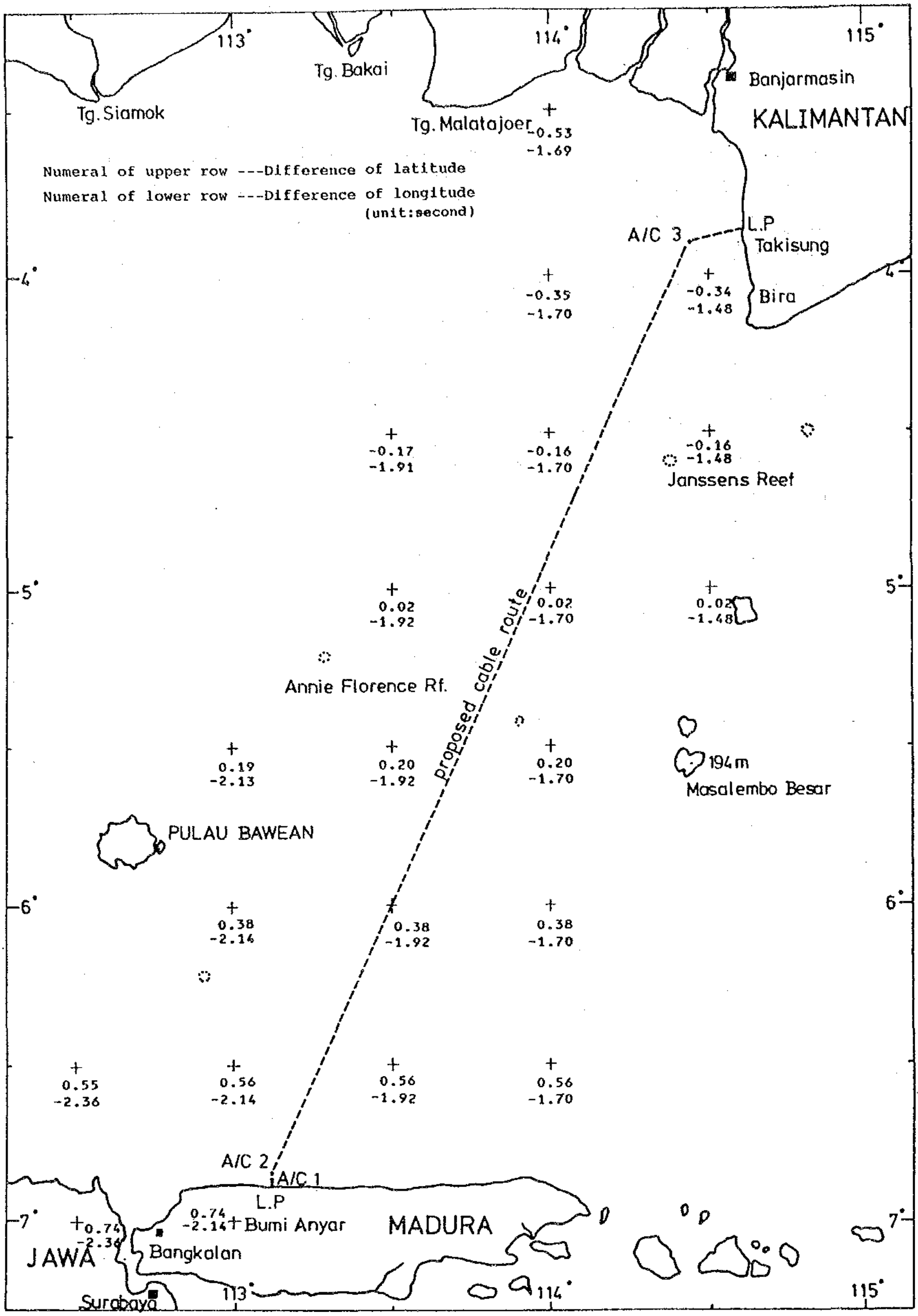


Figure 3-4-1 COODINATES CONVERSION DIAGRAM FROM WGS 72 TO INDONESIA SYSTEM

CHAPTER 4 LANDING POINTS AND CABLE ROUTE

CHAPTER 4 LANDING POINTS AND CABLE ROUTE

4-1 Selection of Cable Landing Point

Generally, on the selection of a cable landing point, following conditions are taken into consideration as shown on the Table 4-1-1.

Table 4-1-1 CONDITIONS OF CABLE LANDING POINTS SELECTION

Actual Condition of Coast (Geographic)	(1)	A point where the cable route length can be made shorter, and it is also desirable that the distance between gate office and landing point is made shorter.
	(2)	Must be free from reefs and other sea bottom obstacles.
	(3)	Must be relatively calm sea condition through the year.
	(4)	The current along the beach is not so strong.
	(5)	Must keep enough space of sandy beach for the cable landing works.
	(6)	A point where a few possibility of occurrence of shore sand drift, earthquakes, tidal waves and floods. And also free from bottom materials such as hydrogen sulfide etc which are not prefered for the cable.
	(7)	A point which keeps enough distance from other plan such as power cable, water feeding pipes, oil pipe line, etc.
	(8)	Must be quite away from the mouth of large river.
	(9)	There is a enough land space which can be procurable to construct the landing station and necessary landing facilities.
	(10)	A point where a railroad, road and jetty does not cross the landing cable line.
	(11)	A point easy to construct a cable protection facilities such as cable conduit, land marks, etc.
	(12)	A point where there is no possibility of replacement of the cable due to coastal water control, construction of jetty, harbor plan, dredging sea bottom, etc.
	(13)	A point which is accessible by existing road for carrying in materials necessary to construct the cable landing station and landing facilities.
	(14)	Must be convenient for station personnel to live.
	(15)	A point where a high reliable connecting landline can be easily obtained or constructed between landing station and gate office.

Table 4-1-1 CONDITIONS OF CABLE LANDING POINTS SELECTION(Contd.)

Fishing activities, ship's operation condition (human and cultural)	(1)	A point where no ship can be anchored nearby.
	(2)	General fishing activities (fishing port, fishing ground, fishing season, number of fishing boats, total fish catch, type of fish, etc.) should be checked to confirm that there is no problems on cable construction and maintenance.
	(3)	Fishing technology (fishing techniques and methods) fishing instruments and devices (fixed netting, octopus, dragnet) should be checked to confirm that there are no problems of cable installation and maintenance.
	(4)	Study and check in advance government guidance, support, and expansion project relating to fishing activities.
Local procurement possibility (cable installation and burying works)	(1)	A point where materials supply base can be set up.
	(2)	A site where local ships (tugboat, crane ship, etc.) and necessary machines used for cable landing works can be easily obtainable.

In selecting a landing point for installation of the cable, a need was felt to decide on the landing point in consideration of a dangerous area in which the mines buried during the World War II may be anticipated particularly on the Surabaya side.
On the intial planning stage, the proposed cable landing points are chosen as shown in Fig. 4-1-1.
The comparison of these four landing point by the items described on Table 4-1-1 is shown on Table 4-1-2.

Table 4-1-2 COMPARISON OF PROPOSED LANDING POINTS

Item \ Proposed Landing Point	A	B	C	D
Ship navigation route	Passed over the cable route	Cable route is on a navigational path	Nothing in particular	Same as C
Fishing activities	Stockade exists near L.P	Small-scale fishing is done	Same as B	Same as B
Anchoring area	Anchoring area	Anchoring area	Nothing in particular	Same as C
Front sea area conditions	Wet land is spreading	Going through Surabaya Straights	Shallow and sandy	Same as C
Dangerous zone	Passing through mine swept area	Passing through mine swept area	Passing through dangerous zone (1 nm)	Passing through dangerous zonn (0.6 nm)
Mine swept area	Passing through swept area (8 nm)	Passing through mine swept area (17 nm)	Passing through mine swept area (9 nm)	Passing through mine swept area (5 nm)
Oil development	Nothing in particular	Nothing in particular	Platform is in extence	Nothing in particular
Installation problem	Construction work is difficult	There is problem of navigational path	Nothing in particular	Same as C
L.P environment	West land is spreading	City area	Nothing in particular	Same as C

Note: Mine swept area is generally safe for navigation, but no safety is assured for sea bottom civil work such as sea bottom excavation.

As mentioned on Table 4-1-2, at the point A, there is a ship's anchoring area in the front offshore and a wet land is spread over wide range. And at the point B, the cable route to Banjarmasin have to pass the ship's anchoring area and also dredging area for ship navigation. Therefore, the point A and B are judged not suitable for the cable landing point. With regard to the points C and D, there are no such problems at present. Accordingly, it is decided that the northern part of Madura included the points of C and D is suitable for cable landing site.

The field survey for selecting cable landing points at the northern part of Madura Island, the survey works was carried out the points of C, D, and other two points as shown on the Fig. 4-1-2.

After the further study of the four points, Bumi anyar (No. 4th point) was selected as the cable landing point because of following reason.

(1) The off shore of Bumi Anyar keeps narrow width of dangerous area caused by mine so that it has advantage of expecting safety construction works.

(2) The cost of investigation of existing mines is much cheaper than other points.

In advance of the ocean survey, detailed field survey was done at the Bumi Anyar beach in January 1986 to determine the cable landing point which will be the starting point of the survey. As the result, taking conditions shown on Table 4-1-1 into consideration, the cable landing point was decided finally at the east side of the beach, the point of which has an open sandy beach and a wide back flat space.

Concerning the landing site of Banjarmasin, it seems to be most suitable for the landing site at the river mouth of the Barito River because of the shortest distance from the Banjarmasin Exchange Office. However, such a river mouth sometimes makes trouble due to a flood. Therefore, the field survey was carried out at the two points of

Takisung and Tabanio where apart from the river and exist a road to the beach. The southern part of two site (Takisung and Tabanio) is not suitable to construct the land commucation line due to the bad road and mountainous conditions.

As the result of field survey, it became clear that the approach road to Tabanio was washed away by a flood. Therefore Takisung was selected as the cable landing site of Banjarmasin side.

In advance of the ocean survey, detailed field survey was also made at the Takisung landing site to determine the cable landing point at the beach and decided early in January, 1986.

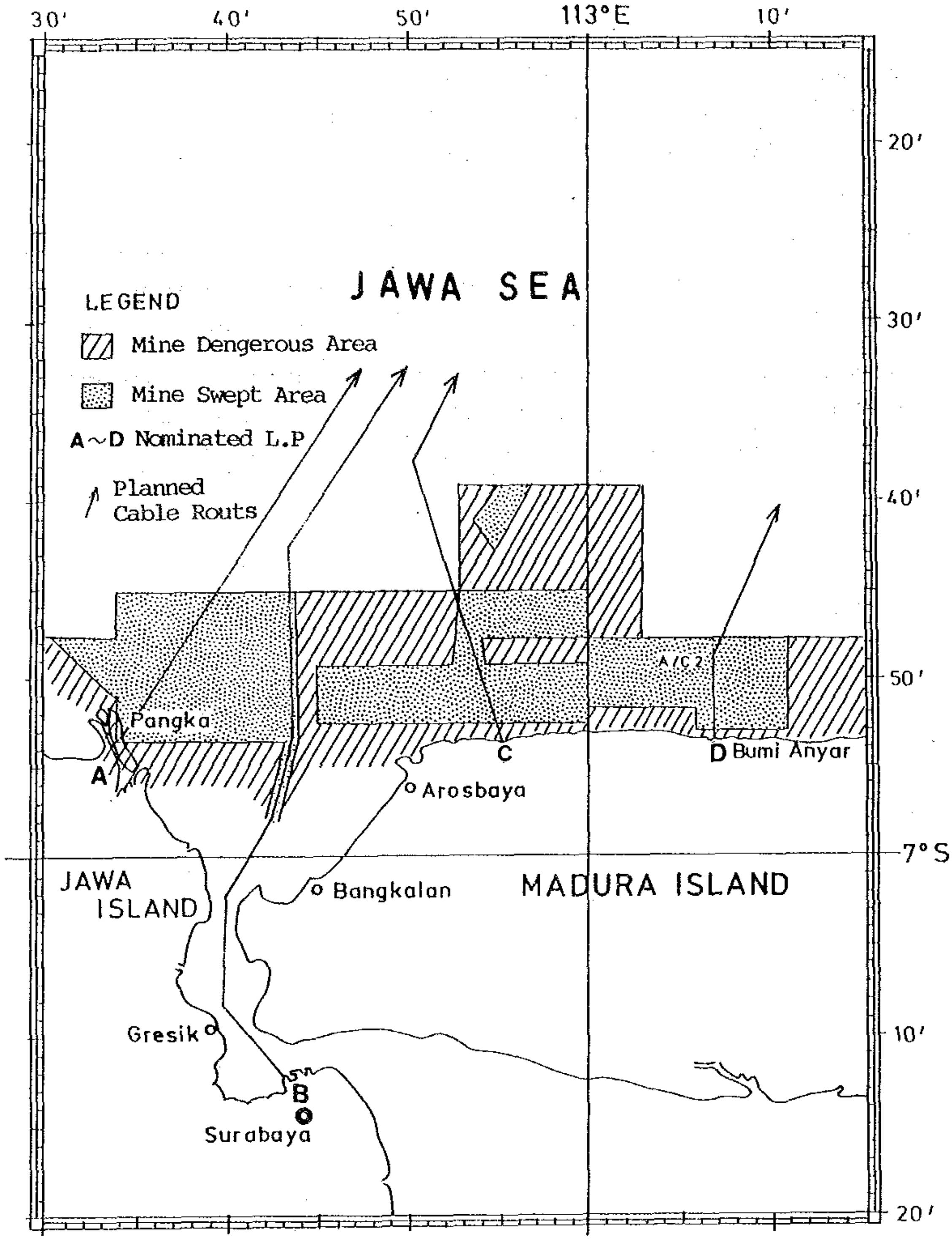


Figure 4-1-1 NOMINATED L.P AT SURABAYA

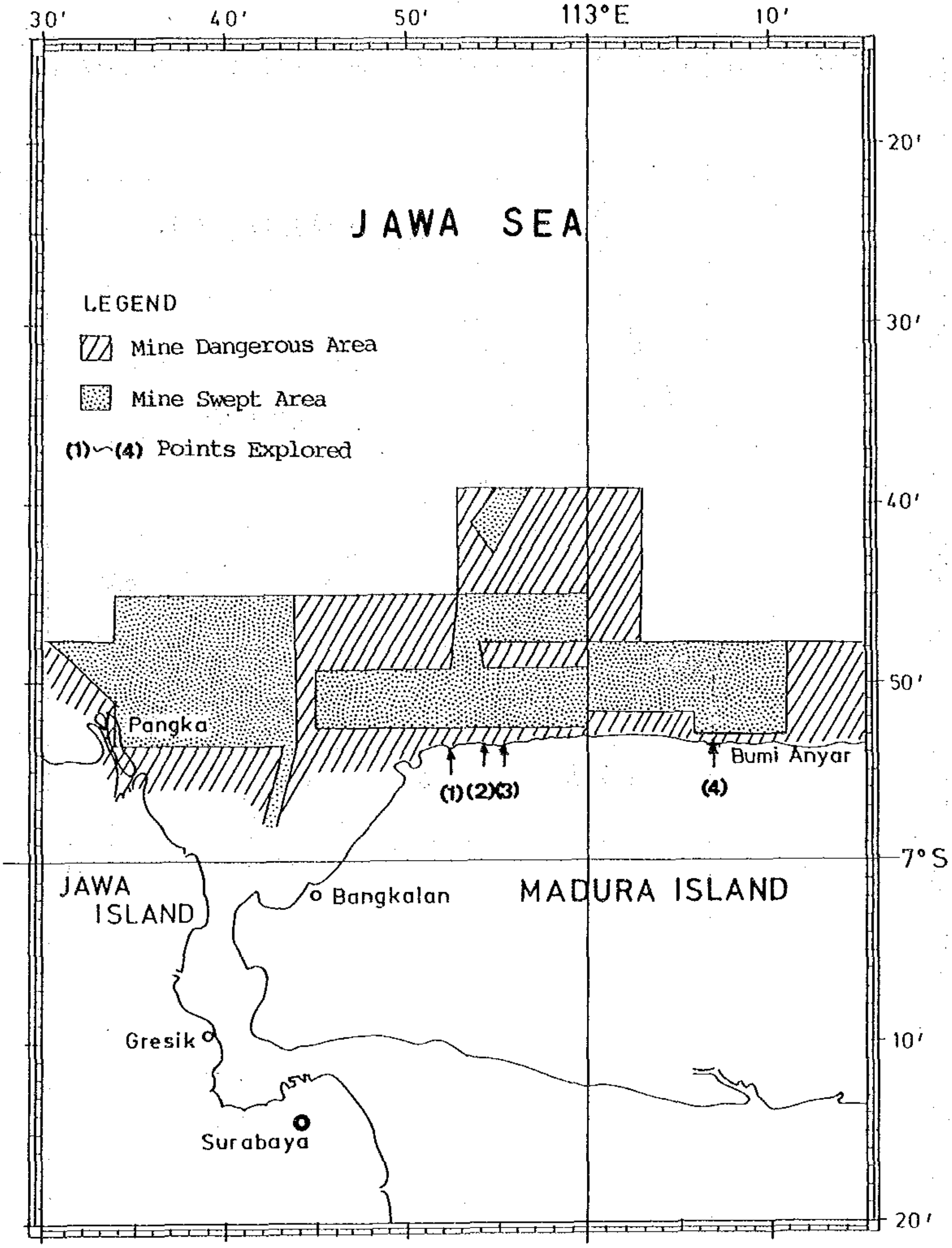


Figure 4-1-2 RESULTS OF EXPLORE ADJACENT L.P

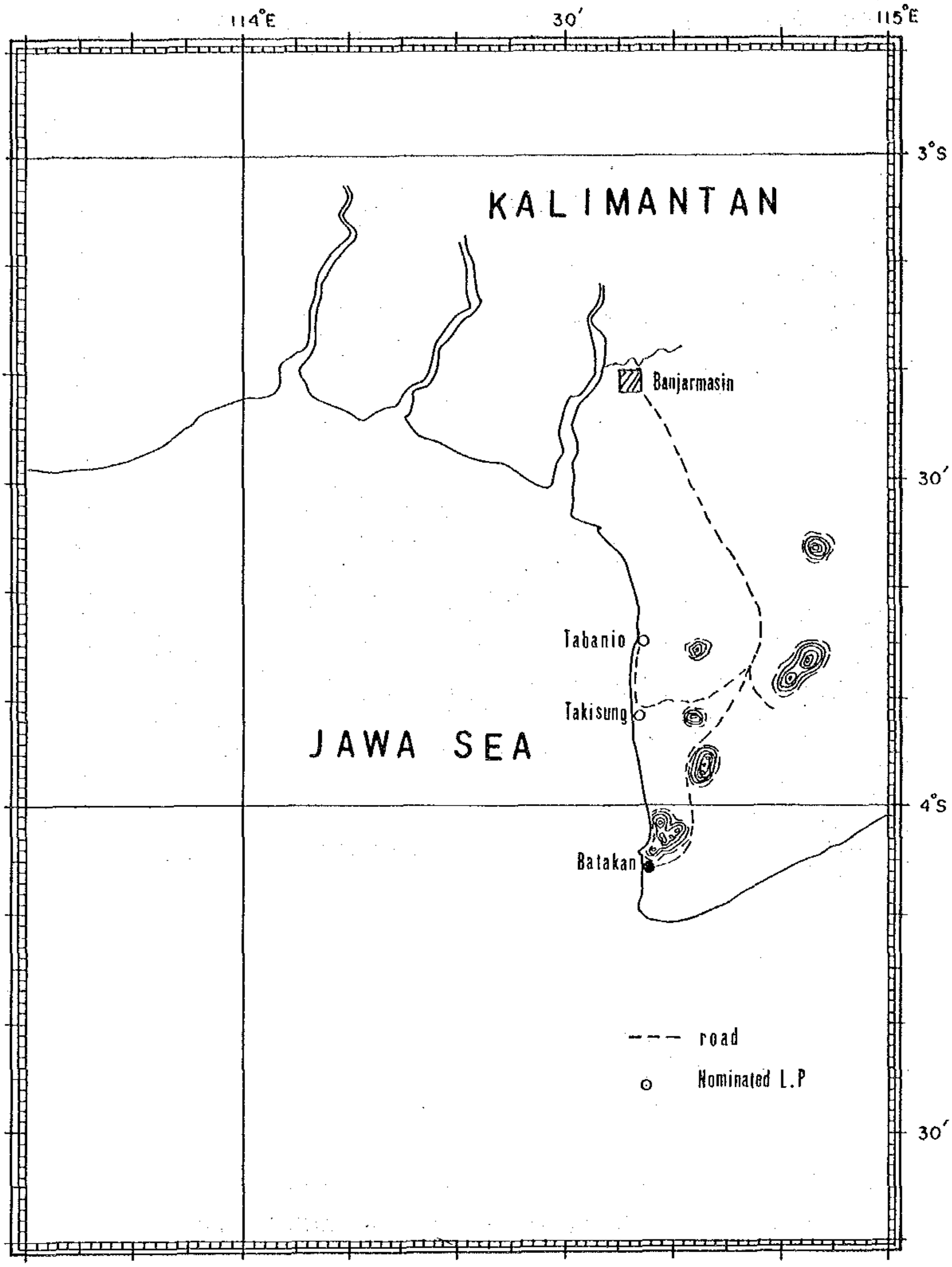


Figure 4-1-3 NOMINATED L.P AT BANJARMASIN

4-2 Proposed Cable Route

The cable route between Surabaya and Banjarmasin was suficiently examined based on existing data before commencement of the ocean survey. The route was established as the planned cable route, and then the survey was conducted on the planned cable route. As the results of survey, it was cleared that the original planned cable route was adequate to the cable route with a little deviation on the side of Surabaya. The proposed cable route is shown in Fig. 1 and Fig. 4-2-1(A) and the sea bottom profile along the route is shown in Fig. 4-2-1(B).

Total distance of the proposed cable route between both L.Ps is 381.47 km. Alternating points and distances between each A/C points are shown in Table 4-2-1.

Table 4-2-1 POSITION LIST ON THE PROPOSED CABLE ROUTE

Pos. No.	Position		Distance (km)	
L.P,A/C	Latitude(S)	Longitude(E)	Between	Cumulation
Bumi-Anyar L.P	6° -53.64'	113° -07.11'		0
			1.50	
A/C 1	6° -52.89'	113° -06.82'		1.50 (0.81 nm)
			7.17	
A/C 2	6° -49.00'	113° -07.00'		8.67 (4.68 nm)
			353.52	
A/C 3	3° -54.50'	114° -26.50'		362.19(195.57 nm)
			19.28	
Takisung L.P	3° -52.43'	114° -36.71		381.47(205.98 nm)

* 1 nm is equivalent to 1.852 km.

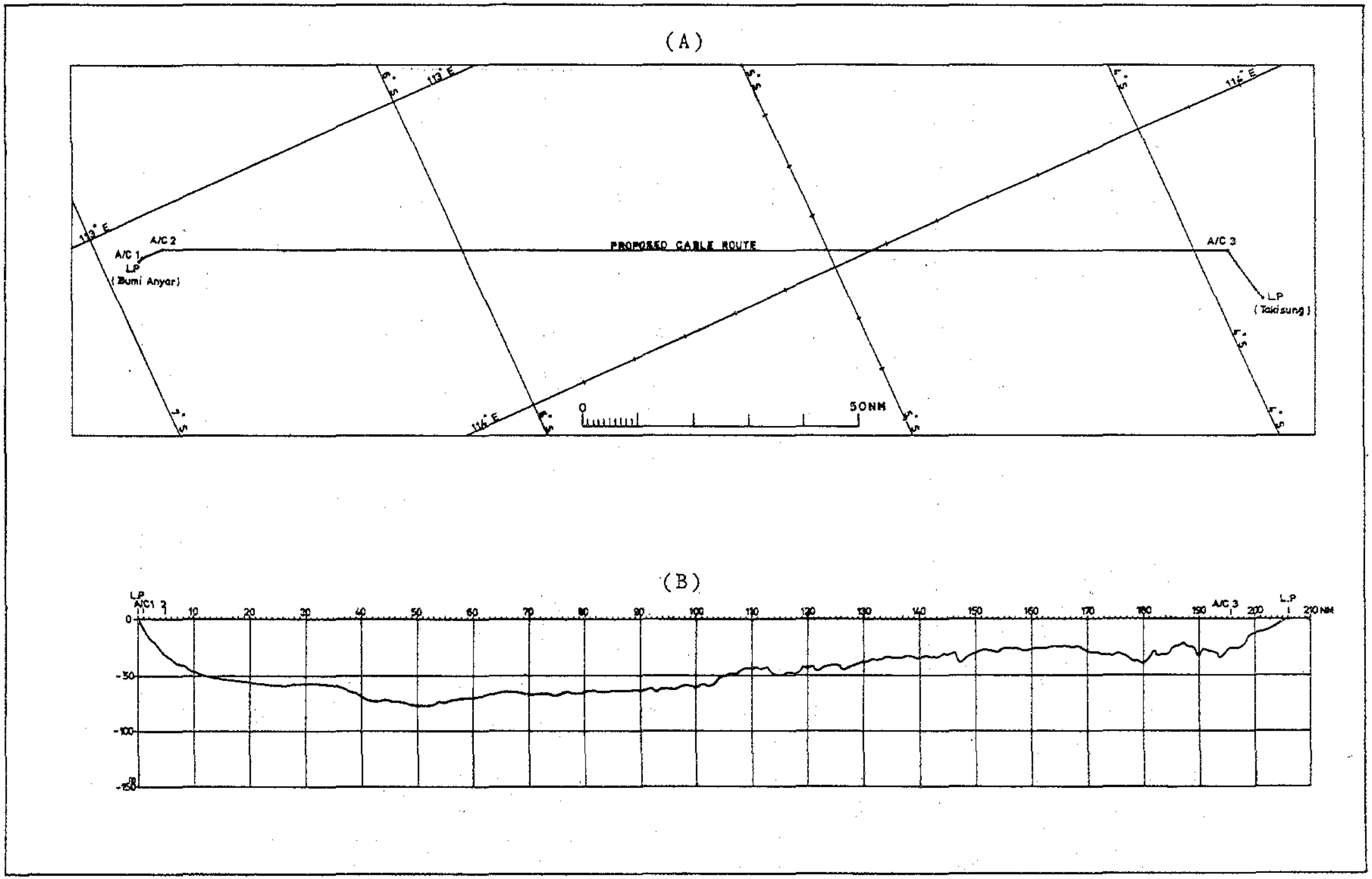


Figure 4-2-1 **BOTTOM PROFILE ALONG THE PROPOSED CABLE ROUTE**

4-3 Route Conditions

(1) L.P at Bumi Anyar to A/C 1

Bumi Anyar in Madura island has been planned as a cable landing point on the side of Surabaya, and the L.P is located on the east of the most inner part of a small bay. This small bay makes dried up area with partly shallow water pudles at ebb tide. Looking around in this condition about sediments, it is observed that sand deposits in a area toward offing approximately 350 m from L.P and the lime-stone consisting of old time (the Tertiary) coral reef exposed in area toward the mouth of bay from at this point.

The mouth of the bay is a surf zone, and a little living coral can be seen in this area.

The stone stacked fish trap facilities applying with ebb and flood tide places and operates in small scale. A part of cable route runs across the fish trapping operation area. The lime-stone formed a surf zone contacts with sandy-mud seabed with a little difference in level. The distance between the surf zone and A/C 1 is about 850 m, and the slope with the gradient of 1/70 occupies half a section of the distance on the land side and the slope with the gradient of 1/225 occupies other half section on offshore side with sandy mud to mud.

This area is a non-swept area for mines, and the magnetic survey was conducted there this time. As a result of the magnetic survey, some-thing equivalent to magnetic quantity for the mine was found along the route 1200 m away from the L.P and 87 m eastside of the route. This was not made to clarlify since this have been burried under seabottom.

(2) A/C 1 to A/C 2

The route in this section extends toward nearly true North with 7.17 km (3.87 nm) of a distance. The seabed slopes simply down toward offing with the gradient of about 1/320. The seabed is covered with soft mudy sediment, the thickness of which is about 6 to 10 m. The route runs with closest clearance to the KODECO oil mining area. As the closest clearance is 2.3 to 2.5 km (1.24 to 1.35 nm), the oil development at present would not directly make hazard to the cable laying.

(3) A/C 2 to A/C 3

The route in this section extends toward Takisung from A/C 2 in direction of Northeast and the distance is 353.52 km (190.89 nm). A seabed becomes gradually deep and reaches the deepest point in water depth 77 m at a point 95 km (51.30 nm) away from L.P at Bumi Anyar. The surface of seabed here is extremely smooth and is covered by soft mud sediment with the thickness of about 6 to 8 m.

The seabed slopes gently upward with gentle undulations (width: 1 - 6 miles, height: 5 - 10 m) from the deepest point to the point 217 km away from the deepest point (168 nm away from L.P at Bumi Anyar). While the sediment of seabed at Bumi Anyar is mainly mud, the sediment of seabed at this side is mainly sandy sediment (mudy sand to sand). The thickness is more than 2 m, but there are three places less than 1 m in thickness. The submarine topography between a point 311 km (168 nm) away from L.P at Bumi Anyar and A/C 3, is a valley topographic feature. It can be seen that there are also large and small undulations on the seabed as mentioned above. According to the nautical chart, it can be estimated this valley topographic features were formed by connection with the rivers on land such as "SUNGAI BARITO" and "SUNGAI KAHAYAN". The sediments on seabed in this section is also mainly sandy sediment in thickness of about 2 to 7 m.

(4) A/C 3 to L.P at Takisung

The valley topographic features can be seen at first part in this section. However, the seabed begins to slope gently upward from a point 368 km (199 nm) away from L.P at Bumi Anyar and splopes a little steeply upward near the L.P at Takisung. The sediment of seabed near A/C 3 is sandy-mud, and then in a area 3 km (1.6 nm) away from L.P at Takisung toward L.P, mud is distributed. Further, the coast near L.P at Takisung is covered with sand, and the boundary between sand and mud locates at a point 200 to 300 m (1.1 to 1.6 nm) away from L.P.

The thickness of sediments on the seabed are generally 2 to 9 m. The area with thickness less than 1 m can be seen in a area toward 3 to 4 nm offing from L.P at Takisung. Beneath the sediment on the seabed, a consolidated and viscous white clay layer exists.

CHAPTER 5 RECOMMENDED SUBMARINE CABLE SYSTEM

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5-1 Type of Recommended Cables and Quantity

5-1-1 Type of Recommended Cable

(1) Land Section (From Landing Station to Landing Point)
To protect the cable from a trouble caused by human activities, it is recommended to use the single armoured cable with direct burying. When the cable crossing a road, a conduit should be installed under the road to protect the cable.

The power feeding ground can be installed near the landing point based from the survey results, and it is recommended to directly bury the ground cable just as in the case of the land cable.

(2) Very Shallow Water Section (Up to Water Depth of 10 m from Landing Point)
To protect the cable from human activities and waves, the double armoured cable shall be buried up to the water depth of 10 m in principle. The point where the water is 10 m deep exists 4 km offshore from the landing point on the Bumi Anyar side, and 7 km offshore on the Takisung side.

On Bumi Anyar side, there are old-type limestone and living coral reef, and the part of area is covered with sediments. In sections where there are no sediments, the limestone and coral should be excavated to create a trench for preventing the cable from its moving by wave.

(3) Shallow Water Section (Water Depth of More Than 10 m)
In this section, cables are generally buried for protection from fishing activities and anchoring.

In this area, trawling is prohibited, and fishing activities are allowed only in the fishing area within 30 nautical miles from the coast by the Government. However while the ocean survey was under way, dolphin and gill net fishing boats were seen here and there often. Therefore to protect the cables from fishing activities and natural faults, it is recommended to bury cables under the sea bottom. Also, it is recommended to adopt the single armoured cable for protection and handllng during laying and burying.

Concerning the dangerous area and mine swept area at the coastal area of Bumi Anyar side, the plow type cable burier used for long-distance cable burying is not suitable for cable burying in this area. Therefore, using water jet type burier for cable burying or using double armoured cable for non-burying laying is recommended.

5-1-2 Required Cable Quantity

The distance between landing points along the selected cable route is 381.5 km, and the cable length between the both landing points is 387.2 km with necessary cable slack of 1.5 per cent(%). Also, assuming that cable length from the respective landing points to the landing station is 500 m, the overall cable length is 388.2 km. The final cable length is subject to changes due to installation plan and system design.

5-2 Recommendations Concerning Submarine Cable System Installation

5-2-1 Work at Landing Point and at Very Shallow Water Area

The front sea area of both landing points is very shallow. So that, the approach of a cable ship to the very shallow water area is limited by draft of the ship. Therefore, the cable laying works from the beach to the point where the cable ship come in, should be done by using flat bottom boat.

Also, the transparency of this sea area is so poor that cable burying after laying is impossible. It is therefore recommended to carry out cable laying and burying work simultaneously using water jetting cable burier.

5-2-2 Ocean Section Laying Work

The transparency of the whole Java Sea is very poor. This makes it difficult, to bury the cable after laying. It is therefore recommended to do cable burying work simultaneously with cable laying.

5-2-3 Land Mark Installation

To protect the cable from a trouble in fishing operation, anchoring, etc., it is recommended to install a land mark for indicating the laid cable route to identify the cable route from fishing boats and vessels.

5-2-4 Enactment of a New Law for Protection of Cable

A new law prohibiting fishing operations, ship's anchoring and offshore industries on the cable ground shall be enacted for protection of the cable from a trouble due to fishing operation and ship anchoring, if possible.