STUDY REPORT
ON
KUANTAN - KOTA KINABALU
SUBMARINE CABLE PROJECT
IN
MALAYSIA

(VOLUME 1)
EXECUTIVE SUMMARY
AND
RESULT OF CABLE ROUTE SURVEY

JANUARY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of Malaysia, the Japanese Government has decided to conduct a survey on the Kuantan - Kota Kinabalu Submarine Cable Project and entrusted the survey to the Japan International Cooperation Agency (JICA).

JICA sent to Malaysia a survey team headed by Mr. Akira Ishii, Sanyo Hydrographic Survey Co., Ltd., from May 15 to August 30, 1986.

The team exchanged views with the officials concerned of the Government of Malaysia and conducted a series of field surveys. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

January, 1987

Keisuke Arita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

January, 1987

Mr. Keisuke Arita
President
Japan International Cooperation Agency

Dear Mr. Arita,

It is my great pleasure to submit herewith a Study Report on the Kuantan - Kota Kinabalu Submarine Cable Project in Malaysia.

The Japanese study team, headed by myself, conducted a field survey on the Project in Malaysia from May 15 to August 30, 1986, at the request of the Japan International Cooperation Agency. The findings of this field survey were analyzed, and the results of route survey as well as the studies for the traffic forecast and basic design necessary for the construction of new submarine cable system between Peninsular Malaysia and Sabah/Sarawak were then complied into this report.

The study shows that the Project is extremely important, so I hope that the Project is executed promptly.

On behalf of the Japanese study team and myself, I would like to express my deepest appreciation to the Government of Malaysia and to the various organizations concerned with the Project for their unlimited cooperation and assistance, and for the warm hospitality which they extended to the team during our stay in Malaysia.

I am also greatly indebted to the Japan International Cooperation Agency, the Ministry of Posts and Telecommunications, the Ministry of Foreign Affairs, the Japanese Embassy in Malaysia and Kokusai Denshin Denwa Co., Ltd. for giving us valuable suggestions and assistance during the field survey and the preparation of this report.

Sincerely yours,

A. Ishii

Akira Ishii
Team Leader
Japanese Study Team for the Kuantan - Kota Kinabalu Submarine Cable Project
(Deputy General Manager, Engineering and Development Headquarters, Sanyo Hydrographic Survey Co., Ltd.)

EXECUTIVE SUMMARY

In order to cover the recent trend of increasing demand for the telecommunication service between Peninsular Malaysia and Sabah/Sarawak, the Government of Malaysia plans to provide a new wideband submarine cable system connecting Kuantan and Kota Kinabalu.

The Government of Malaysia requested the Government of Japan to provide technical assistance on the Kuantan - Kota Kinabalu Submarine Cable Project. In response to the request of the Government of Malaysia, the Government of Japan decided to implement the cable route survey and studies of the traffic forecast and basic design for this submarine cable project by the Japan International Cooperation Agency (JICA).

In the preliminary study conducted in February 1986, the Japanese delegates and members of the Government of Malaysia concerned held a meeting to agree on the Scope of Work for the Route Survey of Kuantan - Kota Kinabalu Submarine Cable Project in Malaysia. The delegates also inspected the cable terminal sites.

Based on the Scope of Work, the Japanese Study Team organized by JICA collected existing data and information, and made a survey plan. After the desk study, the Study Team prepared the Inception Report on the route survey for this submarine cable project. In May 1986, the Study Team submitted and explained the Inception Report to the Government of Malaysia. The Study Team visited Kuantan, Kota Kinabalu and major cities of Peninsular Malaysia and Sabah/Sarawak for the landing sites pre-survey and the study of traffic forecast.

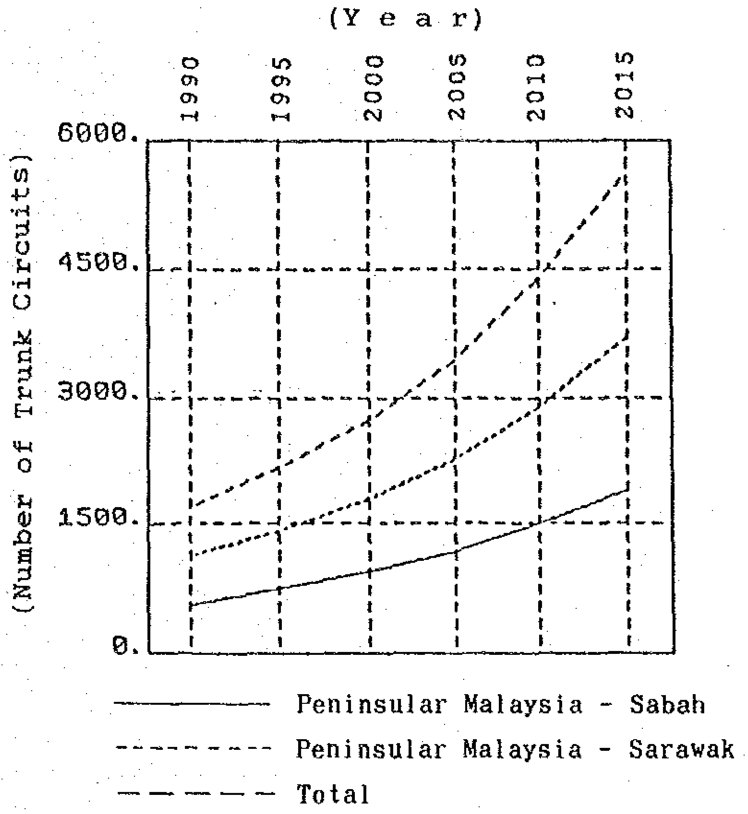
In June 1986, the Japanese survey vessel KAIKO MARU No.5 (500 tons) was sent to Kota Kinabalu, where the Study Team and Malaysian counterpart officials joined the survey vessel.

The ocean survey was conducted over the survey route of about 1,450 km, from offshore Tanjung Aru near Kota Kinabalu to Cherating near Kuantan and back to Tanjung Aru. Several survey items were carried out by using a high accuracy position fixing system under the assistance of the relevant government authority of Malaysia, and the survey was completed on 6th August, 1986. Total sailing distance for the survey amounts to about 5,900 km for going-run, return-run and supplemental surveys.

As a result of the ocean survey, the most suitable cable route could be selected in the vicinity of the cable route suggested by Jabatan Telekom Malaysia. However, some precautions would be necessary against cable damage due to fishing activities or chafing on outcropped rock.

The total length of the proposed route is 1,451.42 km (783.7 nm) between cable landing points. A mean cable slack of 2.7% will be required for the entire route, and the total cable length will amount to 1,489.0 km (804.0 nm).

The Study Team has executed macroscopic demand and traffic forecasts up to the year 2015 based on the traffic data collected in Peninsular Malaysia and Sabah/Sarawak. As a result of its study, the number of the circuits, corresponding to three constant GDP growth rates per annum (2%, 4% or 6%) has been estimated. However, the total number of circuits at the 4% rate is considered to be a normal case, considering the past experiences of Malaysia as well as the other countries. The estimated numbers of circuits between Peninsular Malaysia and Sabah/Sarawak from 1990 up to 2015 are illustrated in the next page.

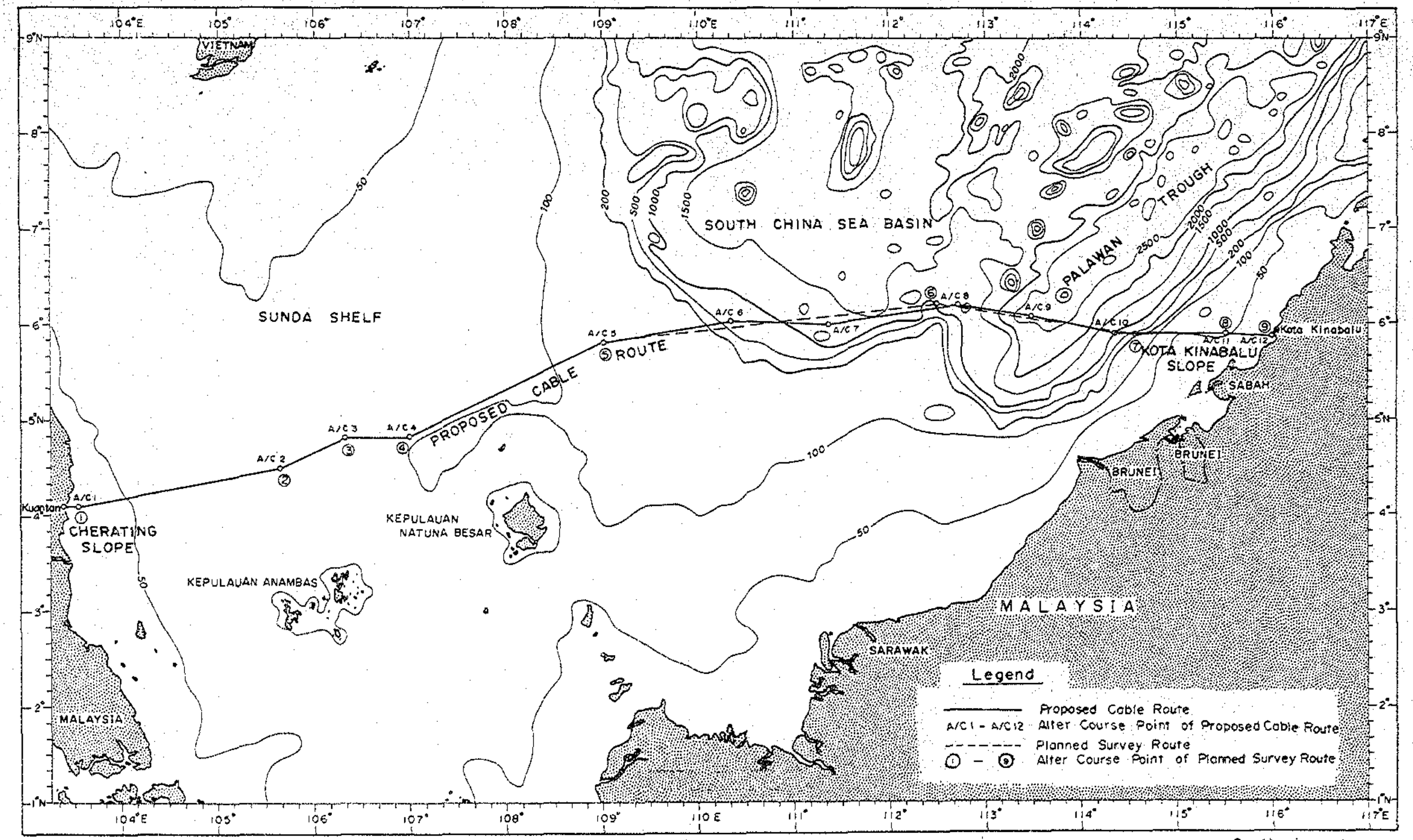


Besides telephone circuits, these also cover the necessary circuits for Telex, Telegram and Data communication. A total number of equivalent telephone circuits for 4% GDP growth rate per annum is applied to the system design of the new submarine cable system.

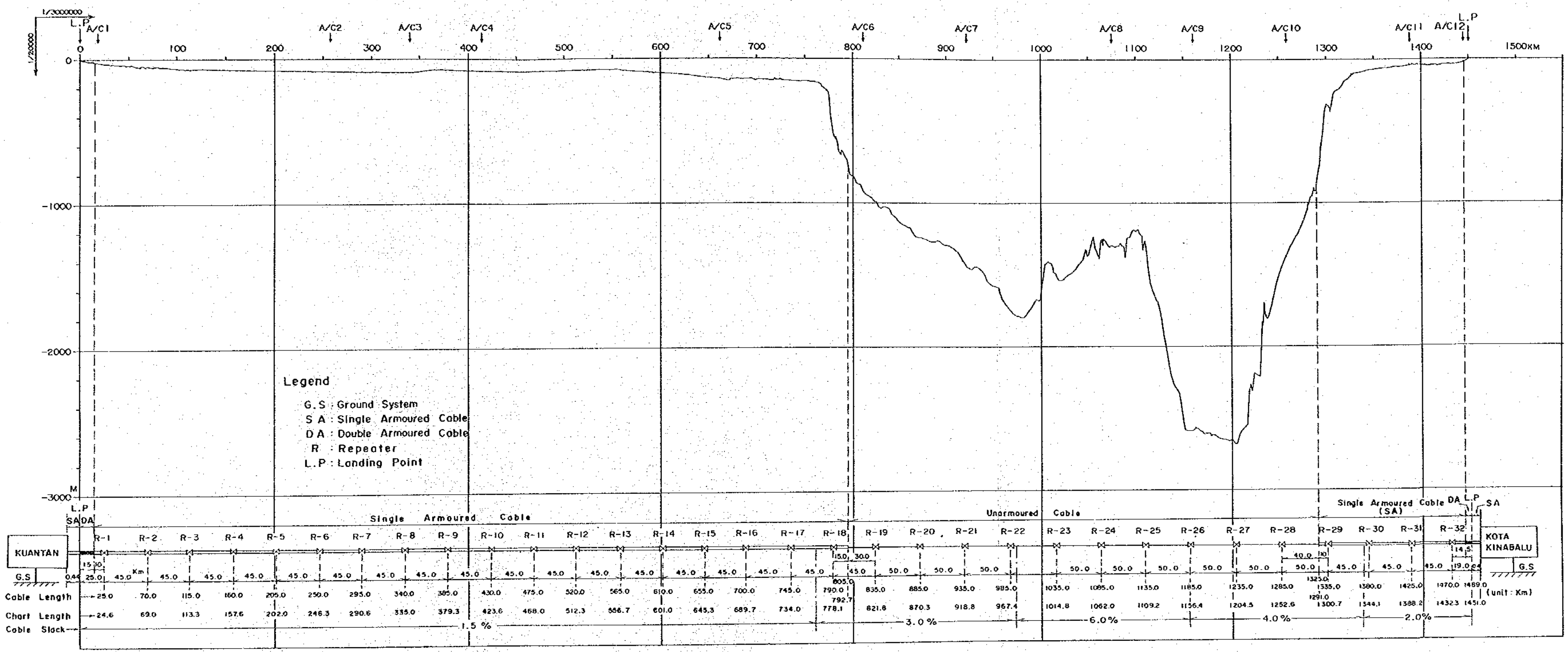
Based on the survey results of the landing sites and the cable route selected by ocean survey and the traffic forecast, the Study Team made the selection of submarine cable system, design requirements and recommendable example of system configuration for the new submarine cable system.

An optical-fiber digital submarine cable system which has a capacity of 2 x 280 Mbps is proposed as a system between Kuantan and Kota Kinabalu. The total required cable length including both land portion cables is estimated at 1,489.84 km (804.45 nm). A Straight Line Diagram of the cable system between Kuantan and Kota Kinabalu was shown by applying the OS-280M system developed in Japan as an example.

The proposed cable route and planned survey route, and seabed profile along the proposed cable route together with the location of submersible plant are illustrated in the next page.



Proposed Cable Route and Planned Survey Route



Seabed Profile Along the Proposed Cable Route and Location of Submersible Plant

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I. INTRODUCTION

I. INTRODUCTION

The Government of Malaysia is planning to provide a wideband submarine telecommunications cable system between Peninsular Malaysia and Sabah/Sarawak.

These areas are presently connected by the following telecommunications media:

(1) Troposcatter system between Johor Baru and Kuching with a total capacity of 144 circuits.

(2) Domestic satellite link between Kuantan and Kota Kinabalu with a total capacity of 72 circuits.

(3) Kuantan - Kuching coaxial submarine cable system with a total capacity of 1,200 circuits.

In order to cover the trend of increasing demand for the telecommunications service between Peninsular Malaysia and Sabah/Sarawak, a new submarine cable system will have to provide a large capacity of circuits to supplement the existing Kuantan - Kuching coaxial submarine cable system which will be fully utilized in the near future.

The Government of Malaysia requested the Japanese Government to provide with technical assistance on the Kuantan - Kota Kinabalu Submarine Cable Project. In compliance with the request, the Government of Japan made arrangements for the implementation of the route survey and studies for the traffic forecast and basic design with respect to this submarine cable project by the Japan International Cooperation Agency (JICA).

From 18th to 28th February, 1986, a Preliminary Study Team, headed by Mr. Akio Mizukoshi, was sent to Malaysia to discuss the Scope of Work to be undertaken by the Government of Japan. The Economic Planning Unit, Ministry of Energy, Telecommunications and Posts and Jabatan Telekom Malaysia (JTM) on the Malaysian side and the Preliminary Study Team from JICA on the Japanese side agreed to the Scope of Work. The Preliminary Study Team made a field inspection of the cable terminal sites at Cherating near Kuantan and Tanjung Aru (Tg. Aru) near Kota Kinabalu from 21st to 26th February. After the field inspection of the sites, Cherating and Tg. Aru landing sites were found to be suitable for the cable landing of the new submarine cable.

Based on the Scope of Work, the Japanese Study Team organized by JICA (the JICA Study Team) started a desk study of this project in Japan. The JICA Study Team collected data and obtained necessary information from the authorities concerned of Malaysia, such as general topography and regional bathymetry, weather and current, fishing activities, offshore oil/gas exploration, existing and abandoned submarine cables/pipelines and ammunition dumping areas, etc. The Study Team analysed the data and information, and made a survey plan. After desk study, the Study Team prepared "The Inception Report on the Route Survey for Kuantan - Kota Kinabalu Submarine Cable Project in Malaysia". (Hereinafter referred to as the Inception Report.)

From 16th to 29th May, 1986, the Study Team, headed by Mr. Akira Ishii, submitted and explained the Inception Report to the Government of Malaysia. As the results of the discussion, the Government of Malaysia and Study Team agreed to the Inception Report.

After submission of the Inception Report, the Study Team, by using a Japanese survey vessel "KAIKO MARU No.5" (refer to Annex-6), conducted the cable route survey from 26th June to 6th August, 1986, under the assistance of the relevant government authorities of Malaysia.

The survey vessel arrived at Kota Kinabalu on 25th June, 1986. Kota Kinabalu (Tg. Aru) landing site survey and inshore survey, as well as the earth resistivity measurement, were carried out from 26th to 30th June, 1986.

The Study Team and Malaysian counterparts joined the survey vessel at Tg. Aru, and the survey of going-run along the proposed survey route from Kota Kinabalu to Kuantan was started on 2nd July, 1986. The going-run survey was completed on 13th July, 1986.

Kuantan (Cherating) landing site survey and inshore survey together with earth resistivity measurement were carried out during the period of 14th to 18th July, 1986.

The survey of return-run from Kuantan to Kota Kinabalu along the parallel line 2 nm south of the survey track of going-run survey was conducted from 20th July to 6th August, 1986.

The Malaysian counterparts and Study Team members left the survey vessel at the port of Kota Kinabalu on 7th and 8th August, 1986, respectively.

The extracts from survey vessel's log book and log of daily events are summarized in Annex-7.

After completion of cable route survey, the JICA Study Team prepared the Interim Report at Kuala Lumpur, and submitted and explained to JTM from 25th to 28th August, 1986.

Item \ Month	1986 Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	1987 Jan.
Preliminary Study	18 — 29											
Desk Study and preparation of Inception Report			2 — 30	2 — 14								
Submission and Explanation of Inception Report				16 — 29								
Navigation (Japan - Kota Kinabalu)					15 — 24							
Landing Site Survey at Kota Kinabalu					26 — 30							
Going-run Survey (Kota Kinabalu - Kuantan)						2 — 13						
Landing Site Survey at Kuantan						14 — 18						
Returning-run Survey (Kuantan - Kota Kinabalu)						20 —	— 6					
Navigation (Kota Kinabalu - Japan)							9 — 20					
Preparation of Interim Report							10 — 22					
Submission and Explanation of Interim Report							25 — 28					
Preparation of Draft Final Report								1 —	— 24			
Submission and Explanation of Draft Final Report									30 ▲	27 —	— 1	
Submission of Final Report												31 ▲

Fig. I-1 Implementation Time Schedule

The Study Team prepared the Draft Final Report including the comments from the Ministry of Energy, Telecommunications and Posts, and JTM, and submitted and explained to the Steering Committee from 27th November to 1st December 1986.

The Study Team prepared the Final Report, and forwarded to the Ministry of Energy, Telecommunications and Posts at the end of January 1987.

The implementation time schedule is illustrated in Fig. I-1.

The members of the preliminary study, route survey and studies for traffic forecast and basic design of this submarine cable project are as follows:

(1) Preliminary Study

Mr. Akio Mizukoshi	MPT	Team Leader
Mr. Kunitake Miyauchi	KDD	Cable Engineer
Mr. Satoru Kamazawa	KDD	Cable Engineer
Mr. Kazuo Ichihara	JICA	Coordinator

(2) Route Survey and Studies for Traffic Forecast and Basic Design

(a) Japanese Team Members

<u>JICA Advisory Committee</u>

Mr. Akio Mizukoshi*	MPT	Chairman
Mr. Haruo Azami*	MPT	Chairman (Successor)
Mr. Taisuke Kitamura*	KDD	Member (Submarine Cable System)
Mr. Junkichi Fujisawa*	KDD	Member (Route Survey)
Mr. Kazuo Ichihara*	JICA	Member (Coordinator)

JICA Study Team

Mr. Akira Ishii	SHS	Study Team Leader
Mr. Yasuo Nishiyama	SHS	Assistant Study Team Leader, Oceanographer
Mr. Yasuaki Kawabata*	SHS	Traffic Engineer
Mr. Fujio Kinoshita*	SHS	System Engineer
Mr. Kunitoshi Hashimoto	SHS	Geologist
Mr. Ishin Katayama	SHS	Hydrographer
Mr. Yukiharu Watanabe	SHS	Hydrographer
Mr. Akira Ohtani	SHS	Electronics Engineer
Mr. Hirozou Furugaki	SHS	Computer Engineer
Mr. Tetsuo Fujita	SHS	Hydrographer
Mr. Syuji Osada	SHS	Hydrographer
Mr. Mitsuo Yuge	SHS	Geologist
Mr. Hitoshi Iesato	SHS	Hydrographer
Mr. Yasuyuki Yoshihara	SHS	Computer Engineer
Mr. Hiroshi Ikenaga	SHS	Oceanographer
Mr. Youichi Hayama	SHS	Geologist
Mr. Kuniaki Akiyama	SHS	Hydrographer
Mr. Takashi Araki	SHS	Hydrographer
Mr. Hisaaki Makiuchi	SHS	Oceanographer
Mr. Tetsuyuki Nishinomiya	SHS	Oceanographer

(b) Malaysian Counterparts

Kota Kinabalu Landing Site and Going-run Surveys

Mrs. Sharifah Aamenah Aljunid*	JTM, External Division
Mr. Zaini Diman	JTM, Sabah Region
Mr. Salim Jamiun	JTM, Cherating Cable Station External Division
Mr. Saidin Hj. Gandul	JTM, Sabah Region

Kuantan Landing Site and Return-run Surveys

Miss Fauziah Kalam*	JTM, External Division
Mr. Ahmad Husny M. Hussin	JTM, External Division
Mr. Tuah Satem	JTM, Sarawak Region
Mr. Bazet Busu	JTM, Cherating Cable Station External Division

Demand and Traffic Forecast

Mr. Yahaya Shariff*	JTM, Switching Division
Mr. David Miasin*	JTM, Sabah Region
Mr. Kassin Hussin*	JTM, Sabah Region

The names of other JTM counterparts appear in Part III (Volume 2) of this report.

N.B. *: Not present during the ocean survey.

JTM: Jabatan Telekom Malaysia
MPT: Ministry of Posts and Telecommunications, Japan
KDD: Kokusai Denshin Denwa Co., Ltd.
SHS: Sanyo Hydrographic Survey Co., Ltd.

II. CABLE ROUTE SURVEY

1. SUMMARY

II. CABLE ROUTE SURVEY

1. Summary

The survey route was selected on the basis of existing charts and data on topography and geology of the seabed with due consideration of the cable route proposed by JTM so as to avoid a submarine cable from danger in the sea area and to minimize the cable length. It starts from Cherating near Kuantan, and crosses the Cherating Slope, Sunda Shelf, South China Sea Basin, Palawan Trough, Kota Kinabalu Slope and extends to Tg. Aru near Kota Kinabalu over a distance of 1,451.42 km (783.7 nm).

The ocean survey was conducted in the going-run and return-run surveys, using the survey vessel "KAIKO MARU No.5". In the going-run survey, the survey was conducted up to offshore Kuantan along the main survey track. (Refer to Annex-9.) The survey was carried out by the following procedure.

(1) Sounding, Sea Bottom Scanning, Sub Bottom Profiling and Existing Pipeline Search in the shallow water portion less than 200 m in depth. (Kota Kinabalu Slope)

(2) Sounding, Sub Bottom Profiling and Current Observation in the deep water portion. (South China Sea Basin)

(3) Sounding, Sea Bottom Scanning, Sub Bottom Profiling and Existing Cable Search in the shallow water portion less than 200 m in depth. (Sunda Shelf and Cherating Slope)

In the return-run survey, the survey was conducted toward offshore Kota Kinabalu along the sub-survey track. (Refer to Annex-9.) The supplementary soundings were also conducted in the areas of complicated topography. The survey was carried out by the following procedure.

(1) Sounding on the sub-survey track up to the offshore Kota Kinabalu.

(2) Survey for Cable Burying in the shallow water portion less than 200 m in depth. (A part of Cherating Slope and Sunda Shelf)

(3) Sea Bottom Sampling, Sea Bottom Photographing, Water Thermometry and Current Observation at fixed points in the Cherating Slope, Sunda Shelf, South China Sea Basin, Palawan Trough and Kota Kinabalu Slope.

The inshore survey was conducted along the coast of Tg. Aru (26th-30th June, 1986) and Cherating (14th-18th July, 1986) using a vessel's launch "Toba No.11" (dinghy). The survey was carried out along the main survey line and two parallel lines, which were 150 m from the main survey line on both sides, up to 6 km from the coastal line. The procedure of inshore survey was as follows:

(1) Setting up of Current Meters at two fixed points.

(2) Sounding, Sea Bottom Scanning and Sub Bottom Profiling along five survey lines.

(3) Bottom Sampling and Water Thermometry at a few fixed points.

(4) Sea Bottom Photographing by diver.

(5) Recovery of Current Meters.

The survey works were conducted in the ocean area and inshore area. In the ocean area, the Global Positioning System (G.P.S.) was used in addition to the hybrid navigation system (NNSS and OMEGA) to obtain accurate position of survey vessel. The positioning data provided by the G.P.S., NNSS and OMEGA navigation system are based on the World Geodestic System (WGS-72). (Refer to Annex-2.)

The accuracy of position fixing is approximately 0.5 nm by using the hybrid navigation system, and this is improved to be within 0.1 nm while three or more satellite signals of G.P.S. are available for positioning.

The inshore survey work was carried out by using the Microwave Ranging System mounted abroad the dinghy. The position dinghy was determined with the distance and bearing by fixing a transit at a guide point, which had been set on the beach in advance, guiding the dinghy to a survey line. The accuracy of this system is about ±3 m.

The survey of land and earth cable routes and earth resistivity measurements were conducted at Tg. Aru and Cherating.

At Tg. Aru, the land and earth cable routes for this submarine cable system were selected along the land and earth cables of abandoned SEACOM cable. The total distance from landing point and earth bed point to the SEACOM cable terminal station along the proposed land and earth cable routes were 373.9 m and 158.5 m, respectively.
An earth resistivity measurement was made near the landing point of SEACOM sea earth cable.

At Cherating, the land cable and earth cable routes for this system were in a straight along the land and earth cable routes of the existing ASEAN M.S.T and Kuantan - Kuching cables from the beach. The distance of land and earth cable routes were 323.0 m and 360.2 m, respectively.
The specific earth resistivity was measured at two points near the beach.

The outline of ocean survey and landing sites survey is listed in Annex-3.

The survey items and objectives of each survey item, and survey equipments together with survey methods are also listed in Annex-4 and Annex-5, respectively.

2. PROPOSED CABLE ROUTE AND REQUIRED CABLE LENGTH

2. Proposed Cable Route and Required Cable Length

2.1 Proposed Cable Route

The Study Team paid close attentions for the selection of planned survey route, which connects Cherating near Kuantan in Pahang, Peninsular Malaysia and Tg. Aru of Kota Kinabalu, Sabah. (Refer to Annex-1.)
The cable route survey was conducted along the planned survey route.

The proposed submarine cable route was selected based on the result of shipboard survey with due considerations of economical view point and high reliability to the new submarine cable system.

Judging from the result of the survey, the Study Team recommends that a route as shown in Fig. II-2-1 is the most suitable route for the Kuantan - Kota Kinabalu submarine cable system. The seabed profile along the proposed cable route is also illustrated in Fig. II-2-2.

2.2 Route Condition

(1) West Continental Shelf Portion

The west continental shelf portion consists of the inshore and offshore areas of Cherating Slope and Sunda Shelf. The distance of this portion occupies about 53% of the whole route distance.

At the inshore area of Cherating Slope (from Cherating Landing Point (C.L.P.) to 6 km from shoreline), the seabed has a regular topography except for partial steep slope near the shoreline. At the offshore of Cherating

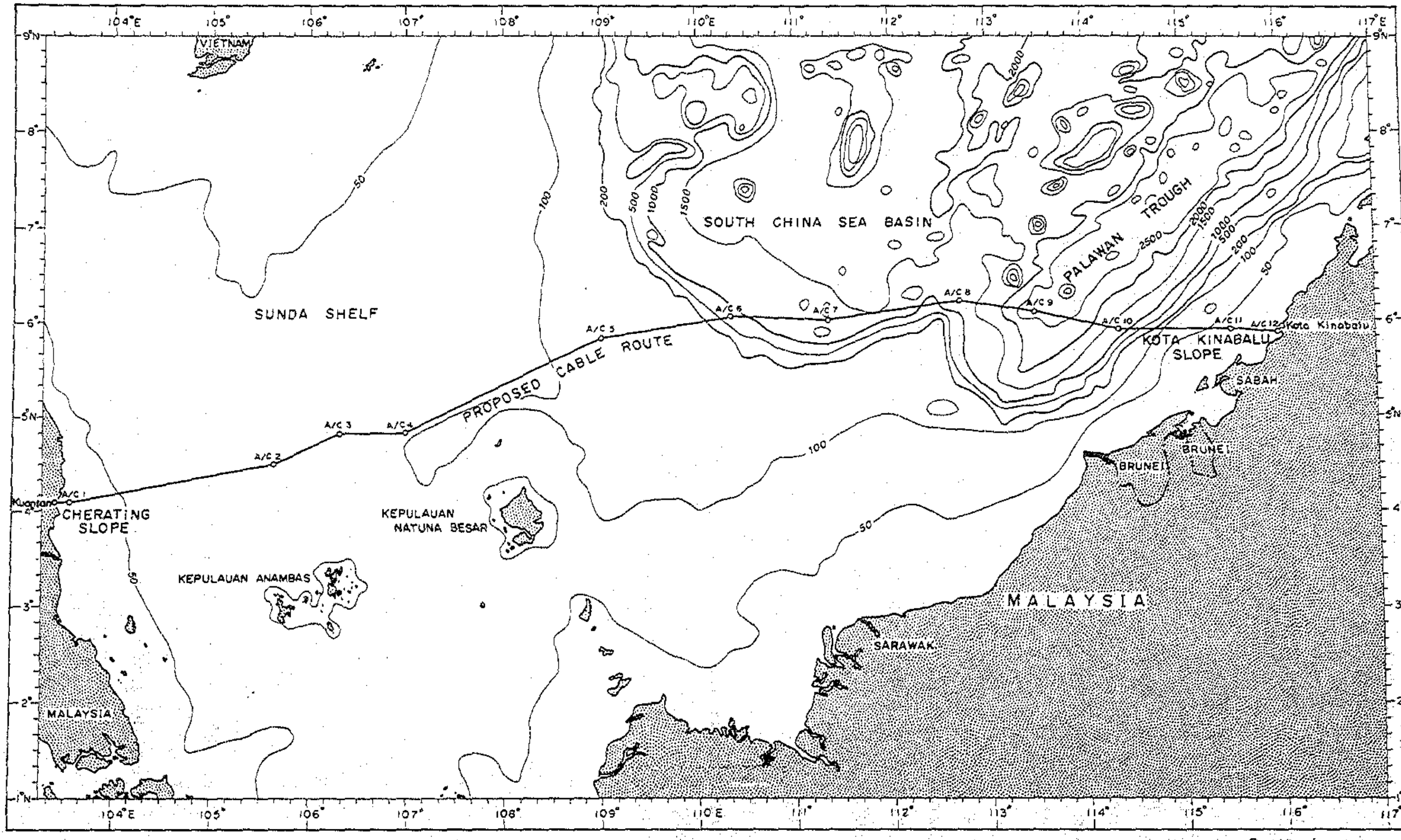

Fig. II-2-1 Proposed Cable Route

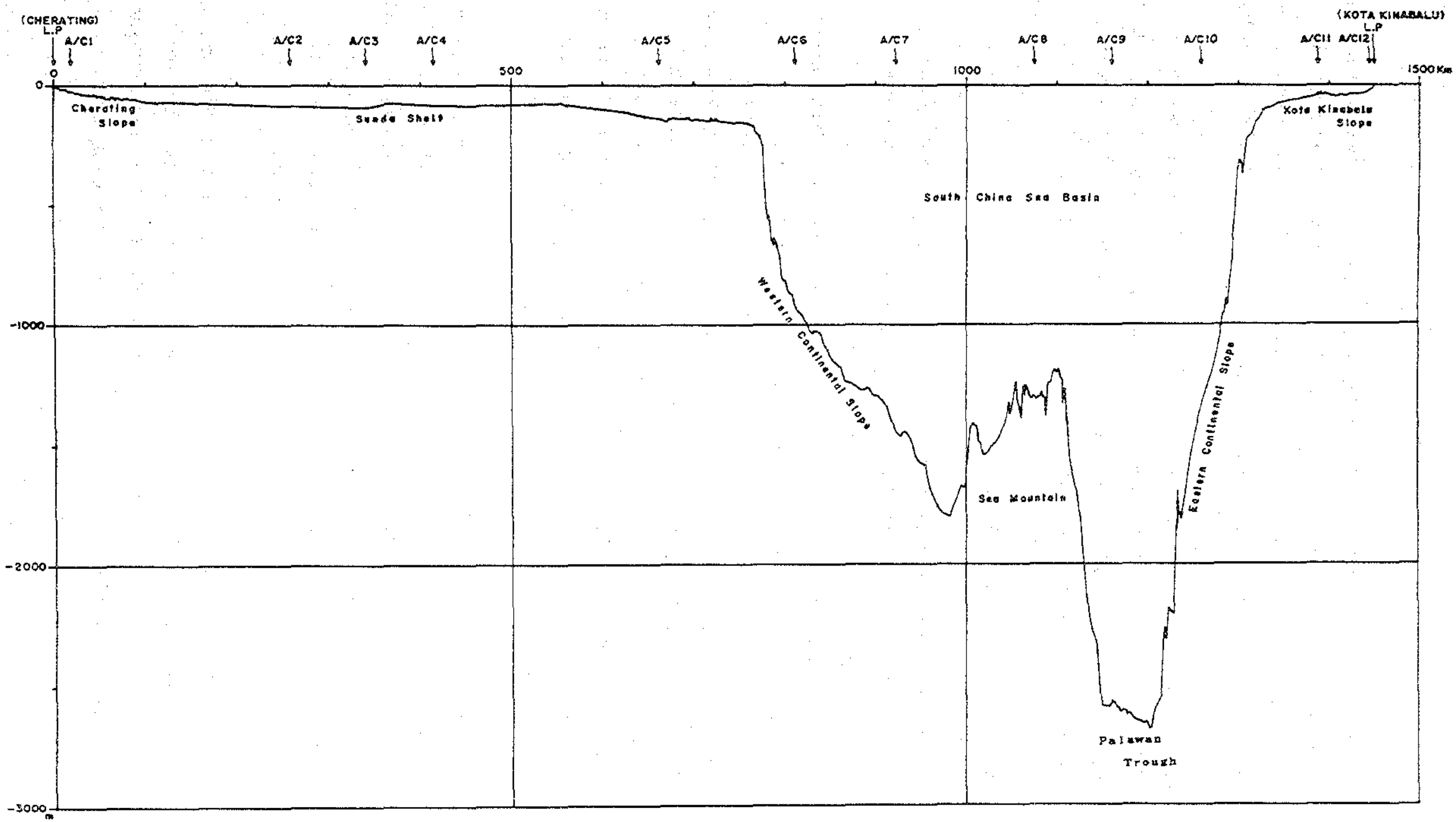

Fig. II-2-2 Seabed Profile Along the Proposed Cable Route

Slope (6 km - 90 km away from C.L.P.), the seabed has a number of undulations. In the area between 9 km and 18.5 km away from C.L.P., seabed material consists of hard sticky clay at the shallow portion below the seabed.

The west part of Sunda Shelf (90 km - 660 km away from C.L.P.) has almost regular topography. The east part of Sunda Shelf (660 km - 770 km away from C.L.P.) has many outcrops consisting of basement rock and coral reefs.

(2) South China Sea Basin Portion

The South China Sea Basin portion divided into four areas by topographical characteristics, i.e., Western Continental Slope, Sea Mountain, Palawan Trough and Eastern Continental Slope. The distance of this portion occupies about 37.5% of whole route distance.

On the Western Continental Slope (770 km - 977 km away from C.L.P.), seabed deepens down to 1,800 m, with a maximum gradient of 1/16 (3.6°). The greater part of the seabed of this area is covered with soft mud except for the outcropped rock area around the margin of the Sunda Shelf.

The proposed cable route pass through the Sea Mountain area (977 km - 1,151 km away from C.L.P.) with a maximum gradient of 1/7 (8.1°), and most of other gradients are less than 1/13 (4.4°). On the east part of this area, the seabed with thick muddy sediment deepens down to 2,600 m, in the edge of Palawan Trough area.

The slope in the Palawan Trough (1,151 km - 1,205 km away from C.L.P.) is almost gentle with mean gradient of 1/450. The seabed deepens gradually from 2,600 m down to 2,680 m, the deepest water depth of the whole proposed cable route. This area is covered with thick muddy sediment.

The Eastern Continental Slope (1,205 km - 1,313 km away from C.L.P.) has rather steep slope as compared with the Western Continental Slope. Some undulations appear on the proposed cable route. The maximum gradient is 1/6 (9.5°).

(3) East Continental Shelf Portion

The east continental shelf portion consists of the offshore and inshore areas of Kota Kinabalu Slope. The distance of this portion occupies about 9.5% of whole route distance.

The offshore area of Kota Kinabalu Slope (1,313 km - 1,446 km away from C.L.P.) has an almost gentle slope, and outcrops of coral reefs with some undulations exist partially.

At the inshore area of Kota Kinabalu Slope (1,446 km - 1,451 km away from C.L.P.), the seabed has a gentle slope and the undulations do not appear on the proposed cable route.

2.3 Items to be Considered on the Proposed Cable Route

Characteristic features which should be taken into consideration as to the proposed cable route are as follows:

(1) The finishing activities which may give damage to a cable are brisk in the shallow sea area of Cherating Slope. Many fishing boats and various fishing gears were observed at the sea area 10 - 15 nm off Cherating.

(2) In the area between 9 km and 18.5 km away from C.L.P., seabed has sticky clay at the shallow portion below the seabed.

(3) The positions of existing ASEAN P.S and S.H segment of S.H.T cables were confirmed by the existing cable search survey. The positions of abandoned Telegraph cables could not be confirmed.

(4) The seabed in the area between A/C 5 and A/C 6 has many outcrops consisting of basement rock and coral reefs.

(5) In the Sea Mountain area, it was observed that undulations of the seabed on the proposed cable route are rather severe.

(6) The seabed in the offshore area on the Kota Kinabalu Slope in outcrop of coral reefs with some undulations.

(7) The two pipelines run in the offshore area of Kinabalu Slope, and they cross the proposed cable route near A/C 11.

2.4 Required Cable Length

The total distance of the proposed cable route between both landing points is 1,451.42 km (783.7 nm). It is estimated that the total cable length is 1,489.0 km (804.0 nm) including 2.7% of cable slack.

The position of each A/C, distance between each A/C percentage of cable slack and cable length are listed in Table II-2-1.

Table II-2-1 Position List and Required Cable Length

Pos. No.	Position (Deg. Mines. Sec.)		Distance (km)		Slack(%)	Cable Length (km)
A/C	Latitude(N)	Longitude(E)	Between	Cumulative		
Kuantan L.P	4-06-20.201	103-23-04.125		0		
A/C 1	4-06-20.40	103-33-00.00	18.38	18.38		
A/C 2	4-30-00.00	105-40-00.00	238.98	257.36		
A/C 3	4-50-00.00	106-20-00.00	82.64	340.00	1.5	772.0
A/C 4	4-50-00.00	107-00-00.00	73.95	413.95		
A/C 5	5-50-00.00	109-00-00.00	247.73	661.68		
A/C 6	6-03-00.00	110-20-00.00	149.57	811.25	3.0	218.0
A/C 7	6-01-00.00	111-20-00.00	110.77	922.02		
A/C 8	6-13-00.00	112-42-00.00	153.45	1,075.47	6.0	195.0
A/C 9	6-06-00.00	113-28-00.00	86.46	1,161.93		
A/C 10	5-55-00.00	114-20-00.00	98.07	1,260.00	4.0	189.0
A/C 11	5-55-30.00	115-30-00.00	129.19	1,389.19		
A/C 12	5-54-44.00	116-00-41.00	56.64	1,445.83	2.0	115.0
Kota Kinabalu L.P	5-57-03.447	116-02-37.646	5.59	1,451.42		
			Total Route Length	1,451.42 km 783.70 nm	Total Cable Length	1,489.0 km 804.0 nm
			(1 nm = 1.852 km)			

Note: Distance is geodestic line distance with WGS-72.
Land Cable is excluded.
Slack depends on rough calculations.

3. UNDERWATER TOPOGRAPHICAL AND GEOLOGICAL FEATURES

3. Underwater Topographical and Geological Features

In order to select the most suitable route between Kuantan and Kota Kinabalu, topographical and geological surveys were carried out. Survey area is located in the southern part of the South China Sea consisting of the Sunda Shelf and the South China Sea Basin. The data obtained by the survey were immediately analyzed on board the vessel to judge the suitability of the cable route. In the section where the condition was found to be unsuitable for the cable route, the supplementary survey work was carried out.

The planned survey route has been changed based on the results of survey as follows:

(1) Around 108 km east of A/C 5 (110°0'E in longitude)

The fault runs from the north-northwest to the south-southeast in this area. The route was altered to the north to select the smaller down-throw of the fault. (Refer to Fig. II-3-1(1/3).)

(2) Around A/C 7 (111°20'E in longitude)

An isolated sea mountain with a relative height of 700 m exists in this area. The route was altered to the south to avoid this sea mountain. (Refer to Fig. II-3-1 (2/3).)

(3) The area 20 km west of A/C 8 (112°30'E in longitude)

Two sea mountains with large relative heights (760 m and 738m in depth of top) exist in this area. The route was altered to the south to select the course passing through the deep portion (col) between both sea mountains. (Refer to Fig. II-3-1(2/3).)

(4) The area between A/C 10 and 50 km west of A/C 10 (113°55'E to 114°20'E in longitude)

Several undulations with steep slopes exist in this area. The route was altered to the south to select the topography which have less and smaller undulation. (Refer to Fig. II-3-1(3/3).)

The seabed profile and gradients along the proposed cable route are summarized in Fig. II-3-2.

The detailed results of the survey are described about the following four areas.

(1) Cherating Slope

(2) Sunda Shelf

(3) South China Sea Basin

(4) Kota Kinabalu Slope

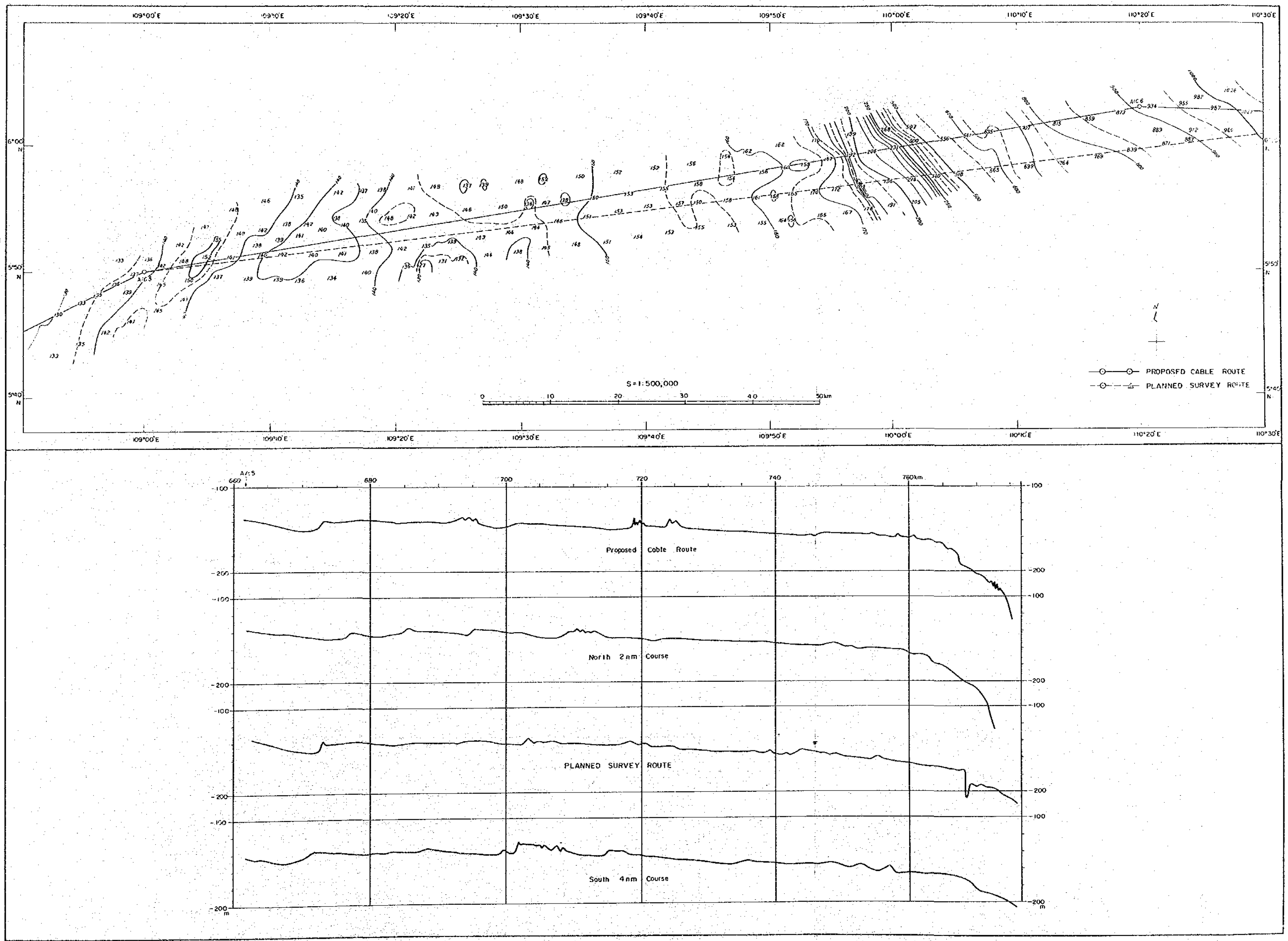

Fig. II-3-1 (1/3) Bathymetric Chart and Seabed Profiles (Eastern Edge of Sunda Shelf)

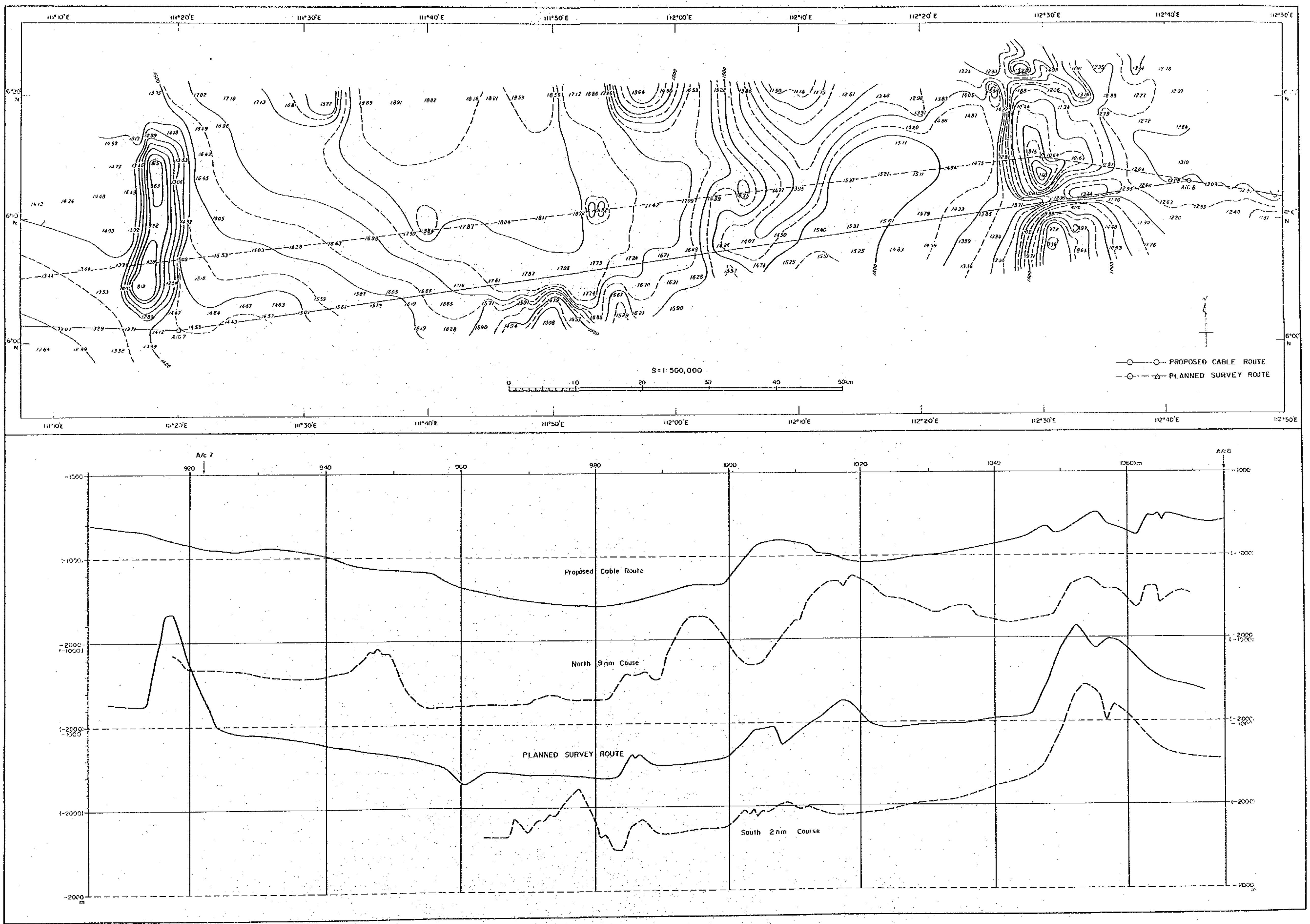

Fig. II-3-1 (2/3) Bathymetric Chart and Seabed Profiles (Western Continental Slope and Sea Mountain)

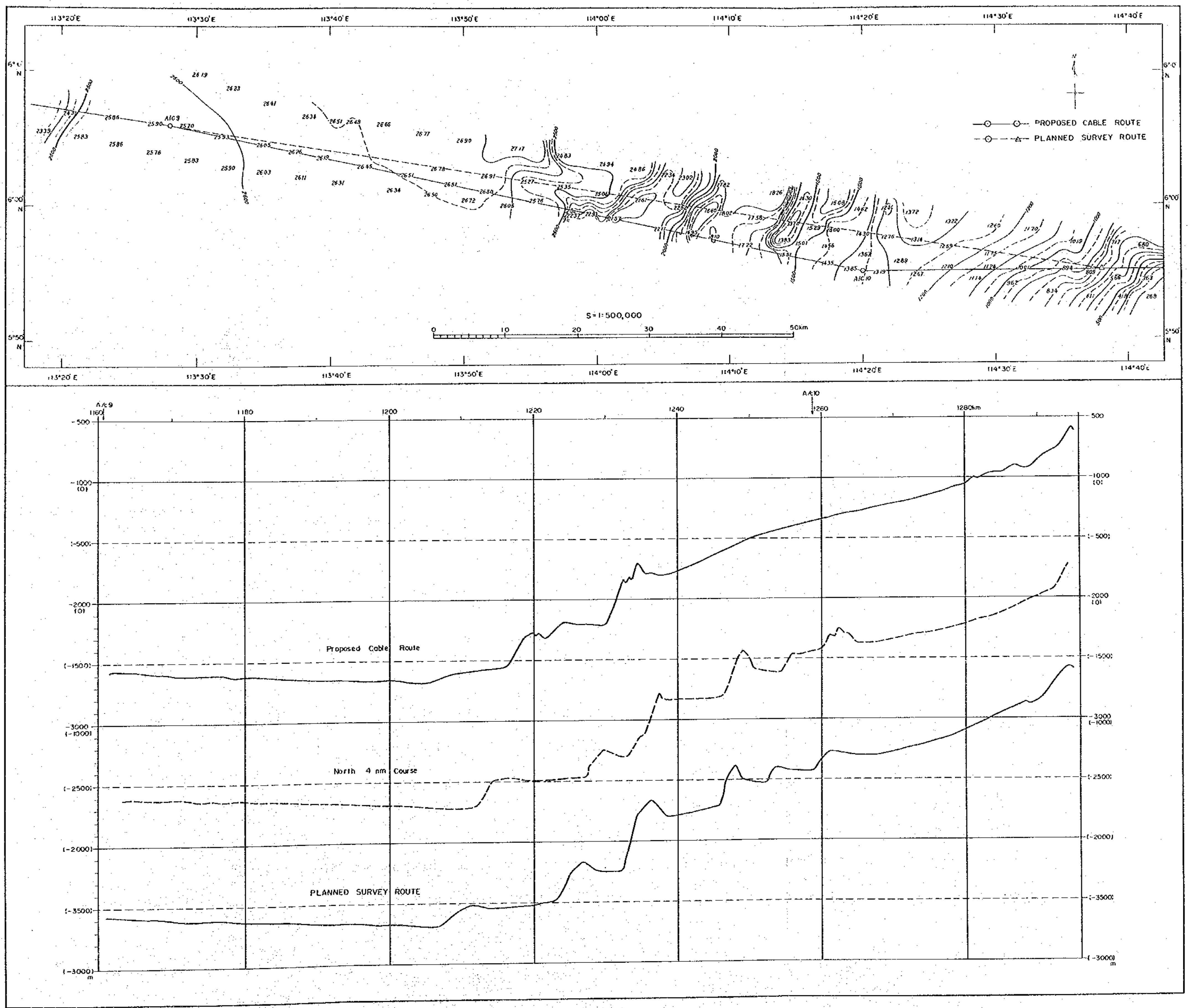

Fig. II-3-1 (3/3) Bathymetric Chart and Seabed Profiles (Eastern Continental Slope)

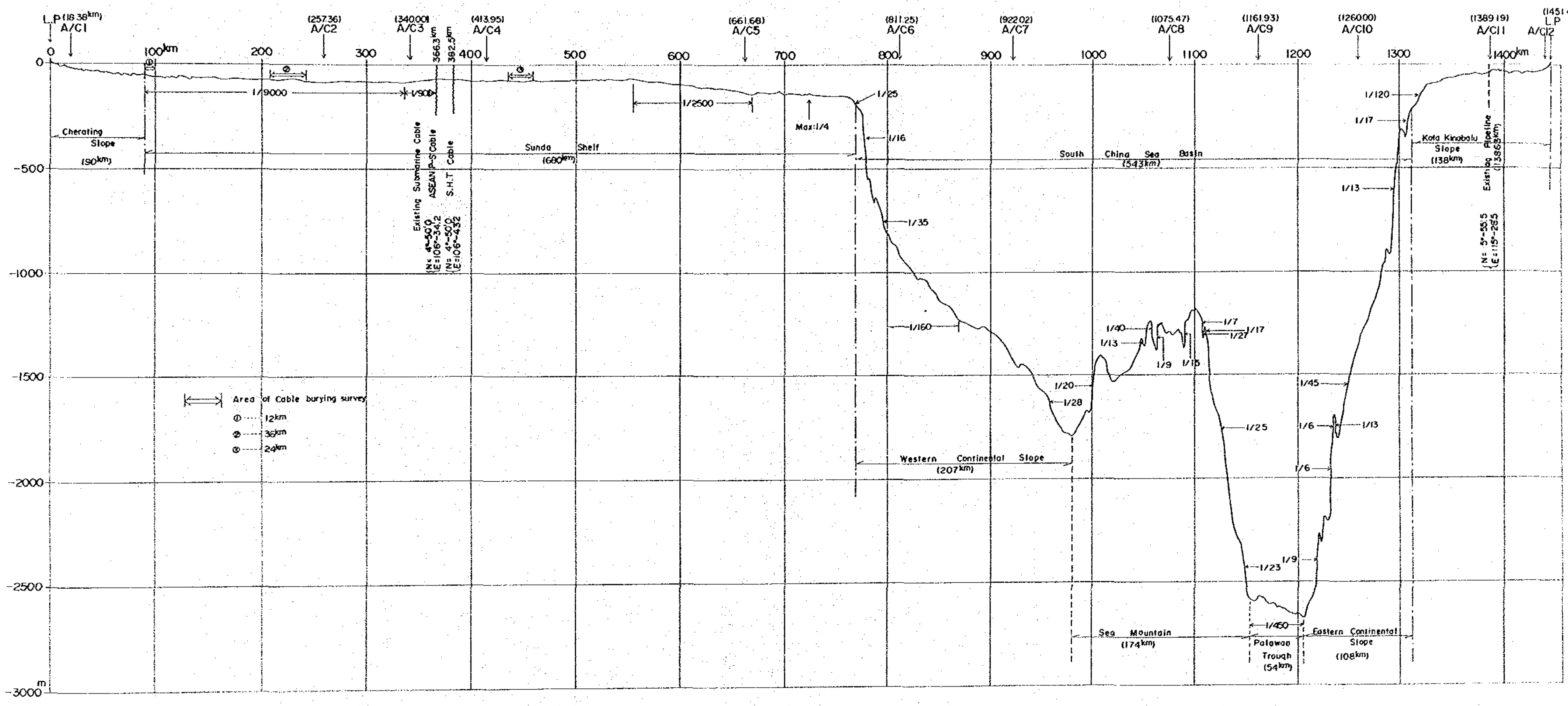

Fig. II-3-2 Seabed Profile and Gradient Along the Proposed Cable Route

3.1 Cherating Slope

The topography of inshore area (from Cherating Landing Point (C.L.P.) to 6 km offshore) is smooth, and the gradient in this section is rather steep near the shoreline, and it gradually becomes gentle toward the offshore, as manifested in the table below. (Refer to Figs. II-3-3, II-3-4, II-3-5 and II-7-1.)

Section (Distance from C.L.P.)	Depth	Gradient
0 to 38 m	+5.6 to +1.8 m	1/9 (6.3°)
38 to 225 m	+1.8 to 1.6 m	1/60 (1.0°)
225 to 575 m	1.6 to 3.2 m	1/200
575 to 6,000 m	3.2 to 10.4 m	1/700

A number of undulations appear on the seabed in the offshore area (6 km to 90 km offshore C.L.P.), the maximum gradient and the relative height are 1/12 (4.8°) and 13 m, respectively.

The gradient of the slopes in this area is shown in the table below. (Refer to Figs. II-3-3 and II-3-5.)

Section (Distance from C.L.P.)	Depth	Gradient
6 to 20 km	10.4 to 26 m	1/400
20 to 90 km	26 to 58 m	1/1,750

The sedimentary layers are thick in this area. The details of layers are summarized in Table II-3-1 (refer to Figs. II-3-4 and II-3-5).

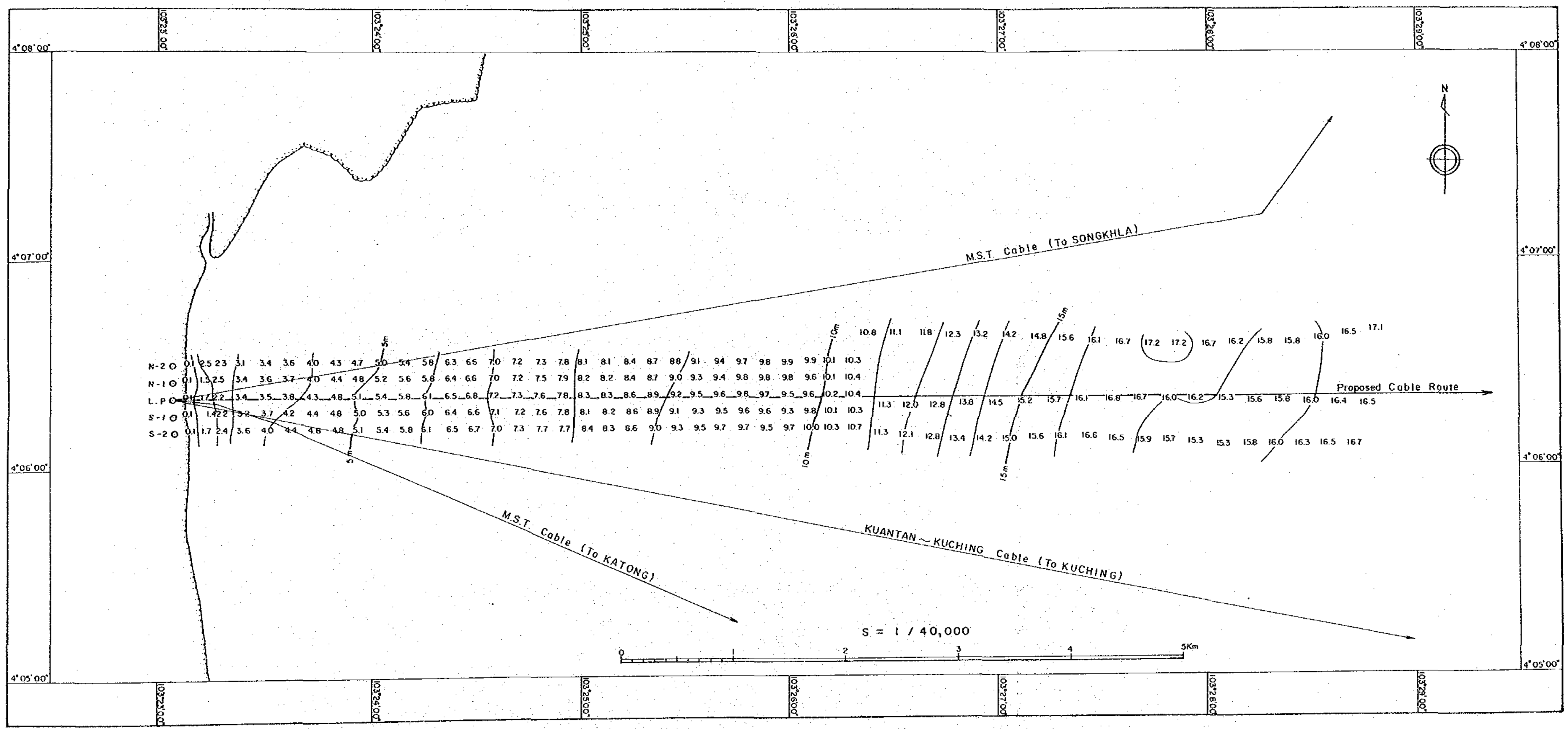

Fig. II-3-3 Bathymetric and Contour Chart off Cherating

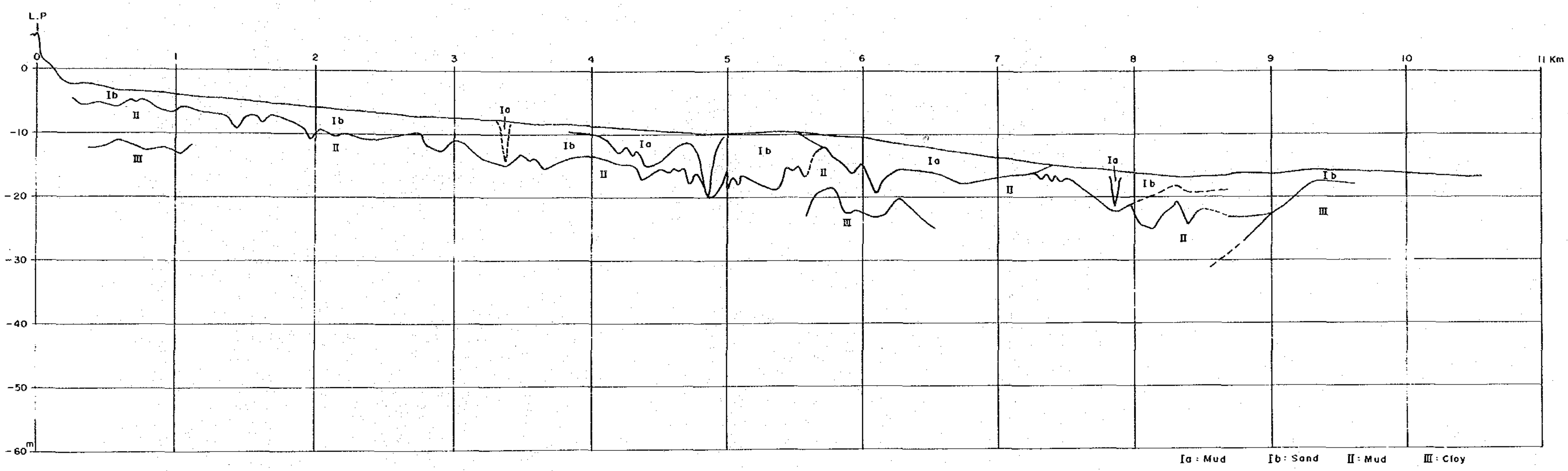

Fig. II-3-4 Seabed Profile and Sub Bottom Layers in Inshore Area (Cherating)

Table II-3-1 Stratigraphy in Cherating Slope

Layer	Soil	Stratigraphy	Distribution (Distance from C.L.P.)	Age
Ia	Mud	Soft and loose mud layer. High water content.	3.3 to 7.4 km	Alluvium
Ib	Sandy Mud	Fine sand near shore. Offshore sand is coarse.	C.L.P. to 18.5 km	
II	Mud	The surface of this layer is irregular. Some parts change to sandy mud.	C.L.P. to 9 km, 18.5 km to the end of Cherating	Later Diluvium
III	Clay	Hard clay sticky and homogeneous.	Whole area	Early or middle Diluvium

It is estimated that layers Ia, Ib and II will not cause any obstructions to cable burying, because of the looseness of the material. However, as layer III has a shear strength of about 0.3 kgf/cm^2 (refer to Table II-4-5 and Fig. II-4-3), and it is a hard and sticky layer, it will obstruct cable burying. The layer III appears in the shallow portion of subsurface in the range of 9.5 km to 25 km from the C.L.P., and in this area, the depth of this layer is 10 cm to 3 m beneath the seabed.

In the offshore area more than 25 km away from the C.L.P., the layer I is scarcely found. Therefore, it is understood that the irregular topography of this area results from the erosion in the Diluvium Age.

3.2 Sunda Shelf

The seabed in the area is generally flat, and the gradient changes at three points, i.e., 340 km, 556 km and 670 km away from the C.L.P. And the outcropped rock is distributed in the eastern area of A/C 5. The topographic conditions in this area are shown in Table II-3-2.

Table II-3-2 Topographic Conditions of Sunda Shelf

Section (Distance from C.L.P.)	Depth	Mean Gradient	Topographic Conditions
90 to 340 km (A/C 3)	58 to 90 m	1/9,500	Gentle undulations exist in places but the scale of undulations are small.
340 to 556 km	90 to 74 m	1/9,000	Pits (gas holes) scatter. Diameter: 3 to 10 m Relative height: 1 to 3 m
556 to 670 km (A/C 5)	74 to 135 m	1/2,500	Gas holes scatter. Diameter: 1 to 3 m Relative height: less than 1 m. (Table II-4-7)
670 to 770 km	135 to 160 m 160 to 200 m	1/4,000 1/25 (2.3°)	Outcropped rock area. Relative height: less than 20 m Max. gradient: 1/4 (14°) (Fig. II-3-5)

The geological characteristics in this area are summarized as follows:

- o The seabed in the western area of A/C 5 is covered with thick sediments. This sediments correspond to the layer II. (Refer to Table II-3-1 and Fig. II-3-5.)

- o The layer II mostly consists of muddy sediments, but layer II around P-10 and in the eastern area of 520 km away from C.L.P. consists of sandy sediments, where this layer is an uppermost layer. The layer II in this area is loose and suitable for cable burying. (Refer to Table II-4-4, Figs. II-3-5 and II-4-3.)

- o A number of waste-filled channels has been developed in the layer II. This facts show that the seabed in this area changed into lands by lowering of sea level and was eroded by rivers in Glacial Epoch, and also those indicate that in the following Inter-Glacial Epoch the sea level rose, and this area sunk again in the sea and was filled up by sediments. The waste-filled channels spreading over a number of layers suggest the repetition of the Epochs, i.e., Glacial and Inter-Glacial.

- o In the area to the east of A/C 5, the sediments are extremely thin, with a scattering of outcrops of coral reefs, which are well developed on the basement rocks. (Refer to Fig. II-3-5.)

- o From their acoustic patterns, the basement rock is considered to be of alternation of strata of sandstone and shale.

- o The coral reefs tend to grow on the sandstones in the direction of north-northeast to south-southwest. (Refer to Fig. II-4-5.)

- There are two faults with 10 m in relative height are running in this area; the one at 11 km eastward of A/C 5 is down-slope westward, and the other one at 106 km eastward of A/C 5 is down-slope eastward. Both faults are small in scale and gentle in gradient. (Refer to Figs. II-3-1(1/3) and II-4-5.)

- The cable burying in this area is almost impossible.

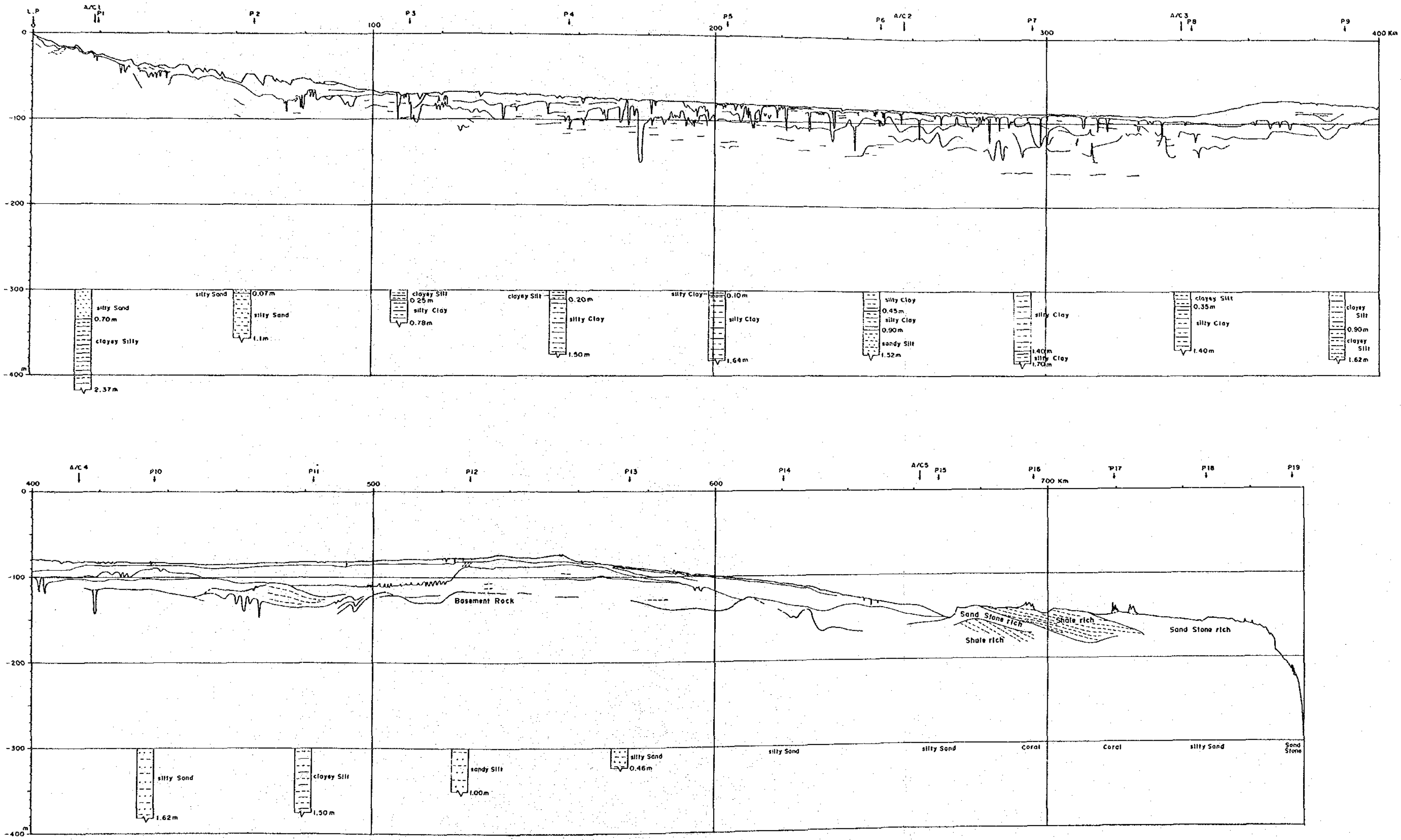

Fig. II-3-5 Seabed Profile, Sub Bottom Layers and Materials in Cherating Slope and Sunda Shelf

3.3 South China Sea Basin

This area has a complicated submarine topography which is divided into four areas by topographic characteristics as shown in the following table. (Refer to Fig. II-3-6.)

Area	Section (Distance from C.L.P.)	Depth
Western Continental Slope	770 to 977 m	200 to 1,800 m
Sea Mountain	977 to 1,151 m	1,800 to 2,590 m
Palawan Trough	1,151 to 1,205 m	2,590 to 2,680 m
Eastern Continental Slope	1,205 to 1,313 m	2,680 to 200 m

3.3.1 Western Continental Slope

This area is the slope which goes down from the margin of the Sunda Shelf towards the bottom of the South China Sea Basin. The proposed cable route traverses this slope obliquely to the east, and its downward slope reaches a valley with small undulations which vary with relative height of between 10 to 30 m. The maximum depth of this valley is 1,545 m. The gradients of this slope are shown in the following table. (Refer to Fig. II-3-2.)

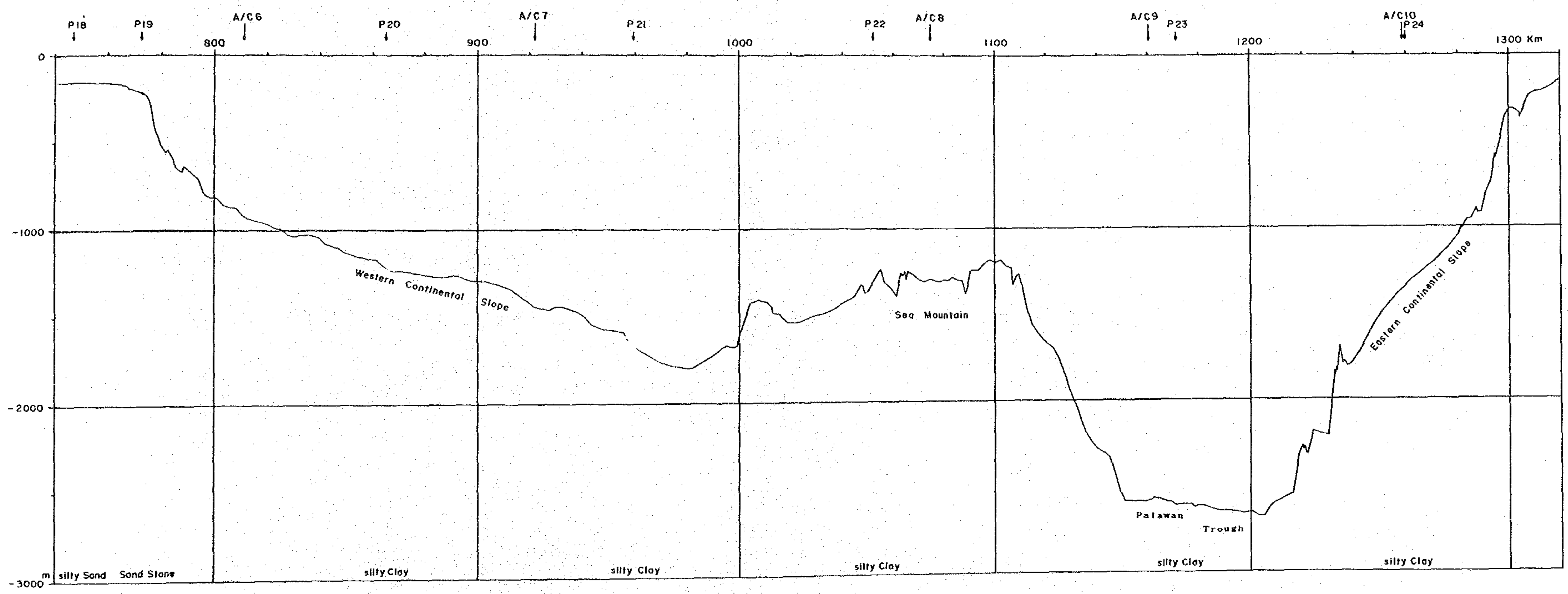

Fig. II-3-6 Seabed Profile in South China Sea Basin

Section (Distance from C.L.P.)	Depth	Gradient
770 to 775 km	about 200 m	1/25 (2.3°)
Around 780 km	about 300 m	1/16 (3.6°)
Around 795 km	about 759 m	1/35 (1.6°)
800 to 870 km	810 to 1,230 m	1/160
870 to 955 km	1,230 to 1,590 m	1/150 to 1/200
Around 957 km	about 1,610 m	1/28 (2.0°)

The geological features of the area are summarized as follows:

- o The seabed in this area is covered with ooze, and an outcropped rock with 27 m in relative height exists in the area about 776 km (340 m in depth) away from the C.L.P.

- o Thick sludge-like sediments exist in the area 800 to 910 km away from the C.L.P.

- o There are innumerable small undulations (relative height: 10 to 30 m) on the seabed of this sedimentary area, which are estimated to have been created by the creep phenomena where thick sediment was deformed by its own gravity and subsided into the deeper part. However, this movement is almost negligible, and will not cause any hazards to the cable.

3.3.2 Sea Mountain

Several undulations which have rather steep slopes and large difference of elevation exist in this area between west slope and peak of Sea Mountain. The maximum gradient is 1/7 (8°)

although most of the undulation have a gradient of less than 1/13 (4.4°), as shown in the following table.

Location (Distance from C.L.P.)	Depth at Top Portion	Conditions of Undulation
Near 1,005 km	1,410 m	Scale of undulation is large. Relative height: 200 m Maximum gradient: 1/15 (3.8°)
Near 1,047 km	1,325 m	Scale of undulation is small. Relative height: 50 m Maximum gradient: 1/13 (4.4°)
Near 1,055 km	1,235 m	Scale of undulation is large. Relative height: 140 m Maximum gradient: 1/20 (2.7°)
Near 1,065 km	1,250 m	Scale of undulation is relatively large. Relative height: 125 m Maximum gradient: 1/13 (4.4°)
Near 1,100 km	1,185 m	Scale of undulation is large. Relative height: 165 m Maximum gradient: 1/7 (8°)

The sediments on the west slope from the lower part to the peak are thin. However, three small undulations (relative height: less than 50 m) with relatively steep slopes are found, located in a part of the slope of the large scale undulation approximately 1,055 km from C.L.P. as mentioned above, and the presence of sediments on the slopes of these undulations are unknown.

The west slope between 1,115 km away from C.L.P. and west end of Palawan Trough is covered with thick sediments and the seabed is smooth. The difference in elevation between the top of Sea Mountain and the west end of the trough is about 1,400 m.

3.3.3 Palawan Trough

The seabed in this area is almost gentle slope with the mean gradient of 1/450. The route traverses the trough for a distance of 54 km. The maximum depth of the trough is 2,680 m at the point 1,205 km away from the C.L.P. This area is covered with thick muddy sediments, and it is considered that these sediments are like sludge near the seabed. A number of undulations with small relative heights were found, which are considered to have been generated by the creep phenomena where the sediments deformed and moved over the seabed.

3.3.4 Eastern Continental Slope

The topography in this area has characteristic of steeper slopes than the Western Continental Slope with some undulations in several places. The seabed of the western area of 1,235 km away from the C.L.P. is covered with a thin layer of sediments, however the presence of sediments at two points, i.e., 1,220 km and 1,232 km away from the C.L.P. is unknown.

The eastern area of 1,240 km away from the C.L.P. is a rather gentle slope, and the seabed is covered with muddy sediments.

The conditions of topography in this area are listed in the following table. (Refer to Fig. II-3-1(3/3).)

Section (Distance from C.L.P.)	Distribution of Undulation (Distance from C.L.P.)	Topographic Condition
1,205 to 1,216 km		Smooth seabed. Gradient of slope: 1/37 (1.5°)
1,216 to 1,240 km	1,220 to 1,225 km	Complicated topography. Two undulations. Maximum gradient: 1/9 (6.3°)
	Near 1,235 km	Large scale undulation. Relative height: 110 m Maximum gradient: 1/6 (9.5°)
1,240 to 1,280 km		Smooth seabed. Gradient of slope: 1/37 (1.5°)
1,280 to 1,288 km	1,280 to 1,288 km	Uneven seabed. Several small scale undulations. Relative height: under 30 m Maximum gradient: 1/19 (3°)
1,288 to 1,314 km	Near 1,300 km	Uneven seabed. Gradient of slope: 1/30 (2°) Small scale undulations. Relative height: 60 m Maximum gradient: 1/10 (5.7°)

3.4 Kota Kinabalu Slope

The slope in this area is gentle with some outcrops of coral reefs existing on some parts of the slope. The gradients of seabed are listed in Table II-3-3, and the conditions of outcropped coral reefs are listed in Table II-3-4.

The seabed has a gentle slope, and the seabed surface is smooth in the inshore area. (Refer to Figs. II-3-8 and II-3-9.)

The layer III consisting of hard clay, which exists at Cherating Slope was not observed in this area. The layers I and II are loose; therefore, they will not cause any problems to cable burying.

The layer IV seems to be basement rock consisting of sandstone and shale. (Refer to Figs. II-3-7, II-3-9 and Table II-3-5.)

Table II-3-3 Gradients in Kota Kinabalu Slope

Area	Section (Distance from C.L.P.)	Depth	Gradient
Offshore	1,315 to 1,329 km 1,329 to 1,390 km 1,390 to 1,410 km 1,410 to 1,435 km 1,435 to 1,444 km	200 - 100 m 100 - 36 m 36 - 46 m 46 - 37 m 37 - 25 m	1/140 (less than 1°) 1/970 1/2,000 (down slope) 1/2,800 (up slope) 1/750 (up slope) Small undulations. Relative height: under 5 m Gradient: gentle
Inshore	1,444 to 1,448 km 1,448 to 1,451 km	25 - 12 m 12 - 2.8 m	1/350 1/170

Table II-3-4 Conditions of Outcropped Coral Reefs

Section Distance from C.L.P. (Distance from K.L.P.)	Depth	Condition
Near 1,319 km (132.4 km)	150 to 175 m	Coral reefs are covered with thin sediment, 0 - 2 m.
Near 1,323 km (128.4 km)	about 135 m	Coral reefs are covered with thin sediment, 0 - 2 m.
1,326 to 1,330 km (125.4 - 121.4 km)	95 to 110 m	Outcropped coral reefs area. Width: about 4 km Maximum relative height: 10.2 m Maximum gradient: 1/13 (4.5°)
Near 1,344 km (107.4 km)	77 m	Coral reefs are covered with thin sediment.
1,387 to 1,396 km (64.4 - 55.4 km)	30 to 42 m	Outcropped coral reefs area. Width: about 9 km Relative height: 5 - 10 m Maximum gradient: 1/9 (6.3°)
Near 1,405 km (46.4 km)	about 42 m	Same as above. Width: 500 m Relative height: 2.7 m Gradient: 1/18 (3°)
Near 1,411 km (40.4 km)	40 m	Thin sediment and partially outcropped coral reefs. Width: about 1 km Relative height: 4 m Maximum gradient: 1/12 (4.8°)

Note: K.L.P. ... Kota Kinabalu Landing Point

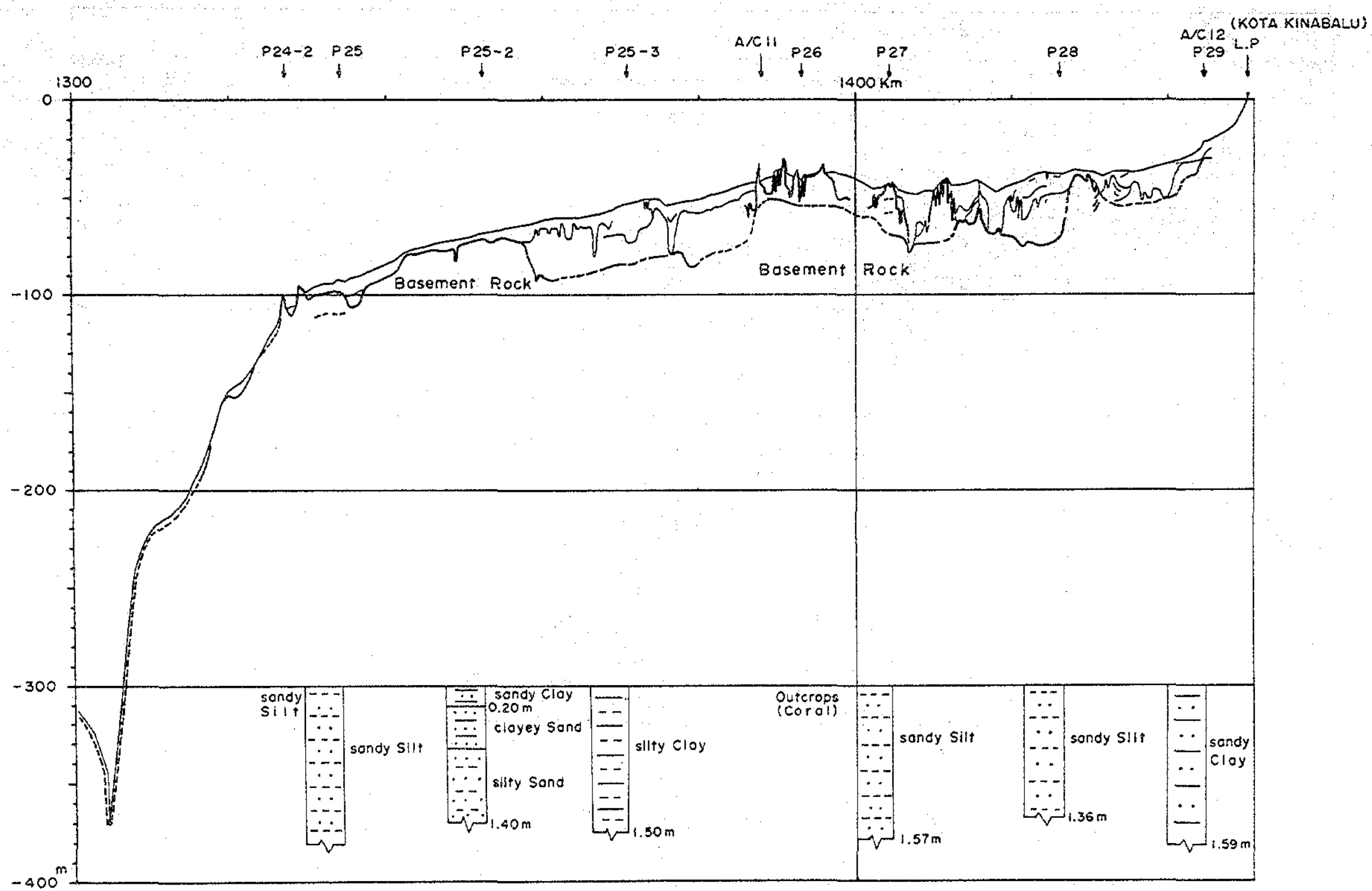

Fig. II-3-7 Seabed Profile, Sub Bottom Layers and Materials in Kota Kinabalu Slope

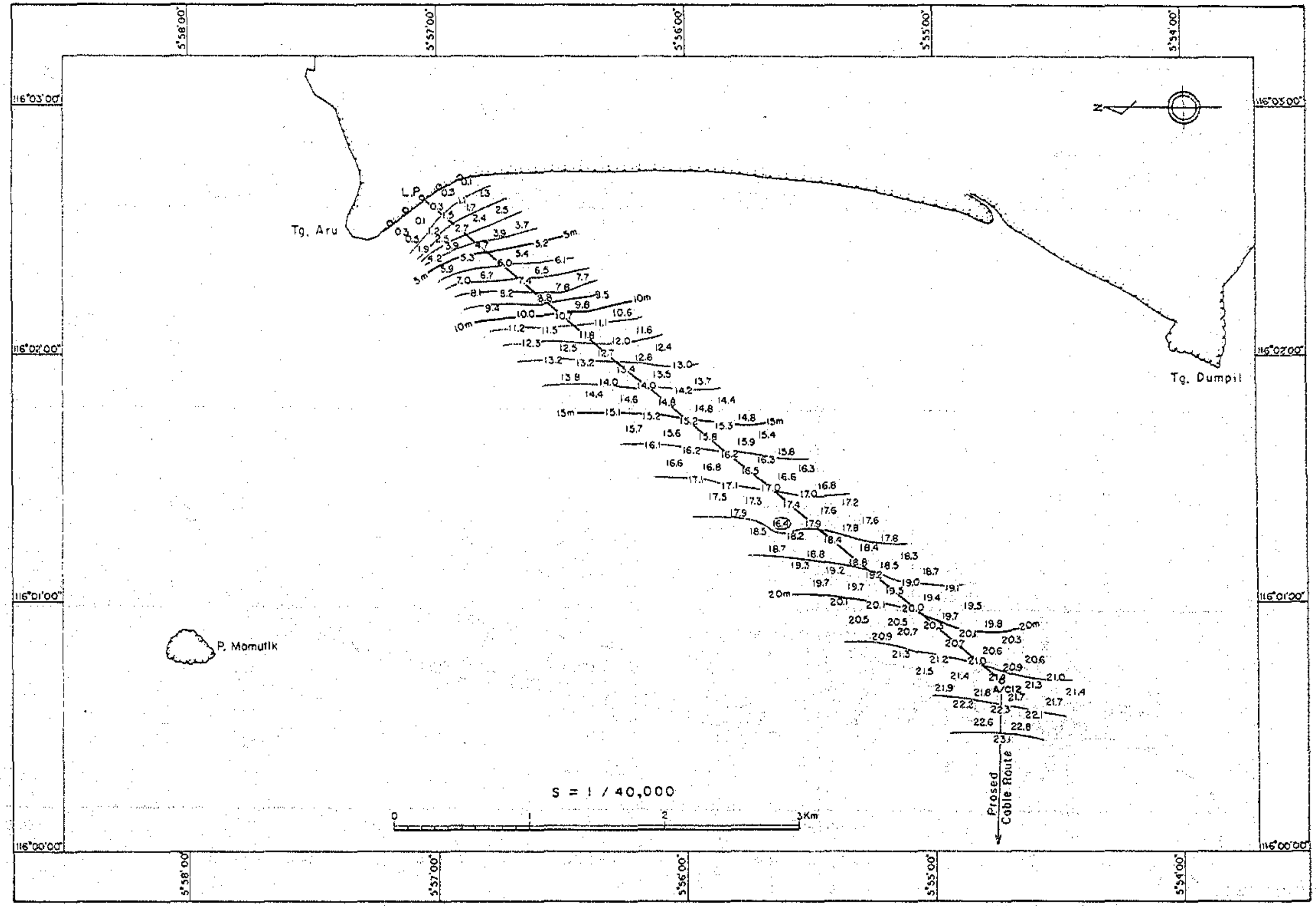

Fig. II-3-8 Bathymetric and Contour Chart off Tg. Aru

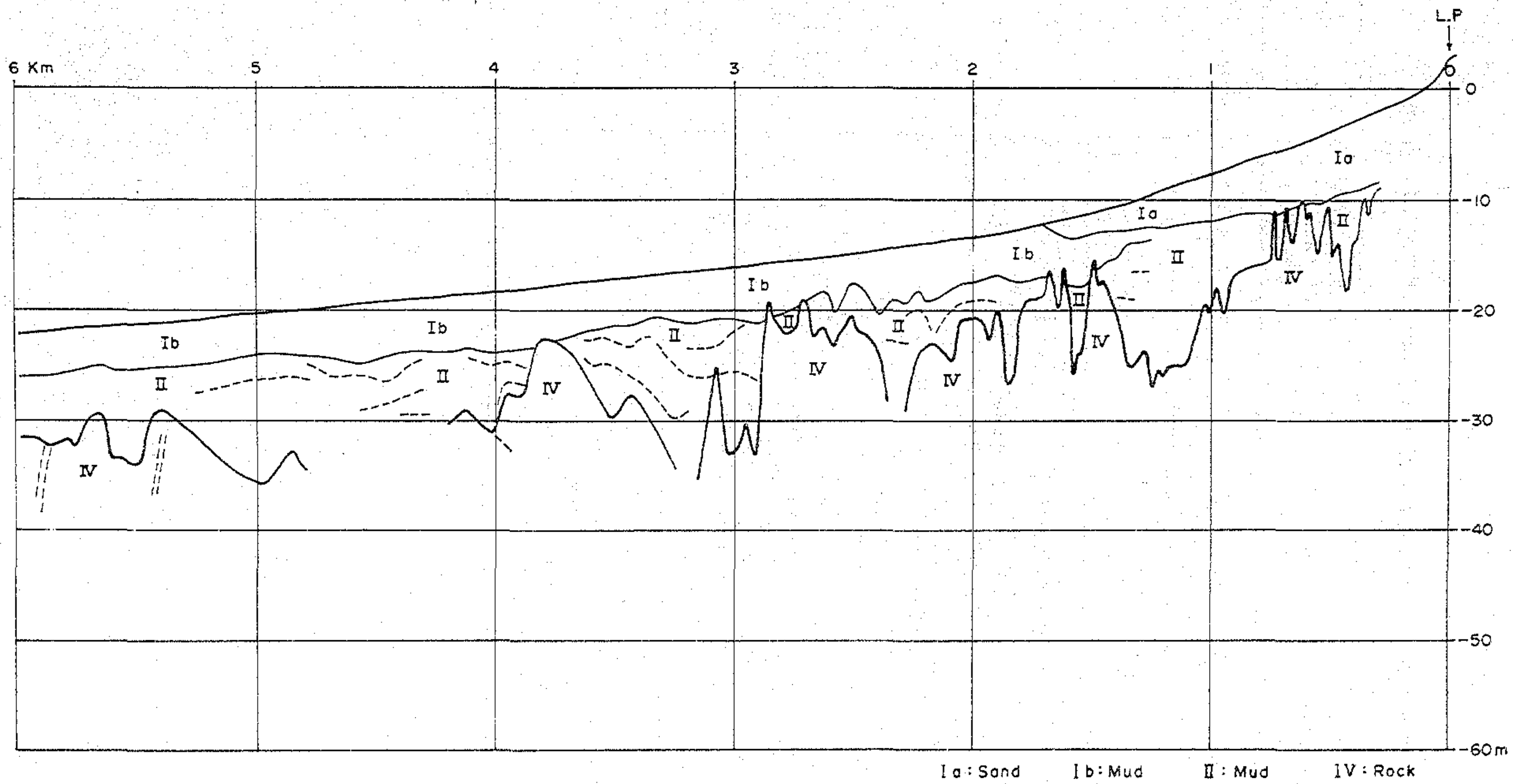

Fig. II-3-9 Seabed Profile and Sub Bottom Layers in Inshore Area off Tg. Aru

Table II-3-5 Stratigraphy in Kota Kinabalu Slope

Layer	Material	Condition	Distribution (Distance from K.L.P.)	Age
Ia	Sandy Mud	Alternate thin layers of fine sand and silt. The ratio of sand becomes greater nearer to the shore.	0.7 to 1.7 km	Alluvium
Ib	Mud	Homogeneous muddy sediments. Silty material becomes in rich nearer to the shore, and clayey material becomes in rich toward the offshore.	13 to 6 km	
II	Mud	Ratio of silty material becomes greater nearer to the shore, and ratio of clayey material becomes greater toward the offshore.	Most of area	Later part of Diluvium
IV	Basement Rock	Alternation of strata of sandstone and shale, with partly developed coral reef on the basement rock.	All area	——