MAIN REPORT
VOLUME 1/1

NATURAL CONDITIONS SURVEY
ON
THE STUDY ON MAINTENANCE DREDGING
IN
THE ACCESS CHANNEL OF BANJARMASIN PORT
IN
THE REPUBLIC OF INDONESIA

MARCH 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

Natural Condition Survey Report
for
The Study
on
Maintenance Dredging
in Access Channel of Banjarmasin Port
in
The Republic of Indonesia

March 1990

Japan International Cooperation Agency

Preface

The Study on Maintenance Dredging in the Access Channel of Banjarmasin Port has been conducted since the end of March, 1988 as one of the technical assistance program through the Japan International Cooperation Agency(JICA) at the request of the Government of the Republic of Indonesia.

The subjects of this study are ;

- To develop measures to reduce the siltation volume in the access channel of the port of Banjarmasin.

- To develop effective measures for the maintenance dredging and

- To formulate a comprehensive plan and a first stage plan to deal with the siltation in the access channel.

Along the abovementioned subject, the Natural Condition Survey was commenced from September 1989 to grasp the actual condition of sedimentation of the access channel.

Contents

-----------------------Data Files------------------------------

[Data for Main Report of Natural Condition Survey]

1. Objects of Natural Condition Survey

The purpose of the natural condition survey is to obtain necessary basic data for hydraulic model test, numerical simulation and countermesure of siltation by conducting survey of meteorology, oceanography, discharge, submarine topography, bottom materials and water quality etc. in the natural condition.
Finally, this survey was carried out basing upon the purpose of The Study on Maintenance Dredging in The Access Channel of Banjarmasin Port in The Republic of Indonesia.

2. Schedule of Natural Conditon Survey

A field survey of natural condition was carried out from 10th September, 1988 to 10th September, 1989 in Banjarmasin, South Kalimantan in the Republice of Indonesia.
The schedule process of the field survey of natural cndition was shown in Table 2.1-1 and Table 2.1-2.

Table 2.1-1 The Schedule of Natural Condition Survey(NO. 1)

Item	Month, Year / Day	September, 1988 (1 10 20)	October, 1988 (1 10 20)	November, 1988 (1 10 20)	December, 1988 (1 10 20)	January, 1989 (1 10 20)	February, 1989 (1 10 20)
Yearlong Survey	1.Tides						
	2.Wind						
	3.Wave & Current						
Monthly Survey	1.River Discharge	24- ①		19- ②	6- ③	7- ④	9- ⑤
	2.Saline Wedge		11-,15- ①	11-,16- ②	10-,13- ③	29-,3- ④	31-,6- ⑤
	3.Bottom Material	24- ①		19- ②	6- ③	7- ④	9- ⑤
			11-,15- ①	11-,16- ②	10-,13- ③	29-,3- ④	31-,6- ⑤
	4.Echo-sounding in Narrow Area		8 (1st	stage) 22	(2nd stage)	14 (3rd; 30	stage) 17; 20 (4th stage); 21 (5th stage)
General Survey	1.Tidal Currents	21	7			24	11
	2.Current Distribution	3 (1st stage)	7			17 (2nd	stage) 19
	3.Buoy Tracking	30	2				14-16
	4.Current Velocity and Turbidity	3 (1st stage)	7			17 (2nd	stage) 19
	5.Bottom Material, Salinity and SS	9 13					21-23
Others	1.Echo-sounding in Wide Area				19	(1st stage)	
Remarks	Dredging Works						

Table 2.1-2 The Schedule of Natural Condition Survey (NO. 2)

Item	Month, Year / Day	March, 1989	April, 1989	May, 1989	June, 1989	July, 1989	August, 1989	September, 1989
Yearlong Survey	1.Tides	1 ————	————	————	————	————	———— 1	
	2.Wind	1 ————	————	————	————	————	———— 1	
	3.Wave & Current	1 ————	————	————	————	————	————	——— 10
Monthly Survey	1.River Discharge	23-⑥	26-⑦	25-⑧	20-⑨	14-⑩, 30-⑪	13-⑫	
	2.Saline Wedge	16-,20-⑥	30-⑦	13-⑦	7-,11-⑧; 24-,28-⑨	7-,10-⑩; 22-,26-⑪	6-,10-⑫	
	3.Bottom Material	23-⑥	26-⑦	25-⑧	20-⑨	14-⑩, 30-⑪	13-⑫	
		16-,20-⑥	30-⑦	13-⑦	7-,11-⑧; 24-,28-⑨	7-,10-⑩; 22-,26-⑪	6-,10-⑫	
	4.Echo-sounding in Narrow Area	8 (5th); (6th stage) ———	——— 13; 26 — (7th stage)	— 4; 25 — (8th stage)	— 3; 16 — 23 (9th)	6 — 18 (10th); 21 — (11th)	— 1; 7 — 14 (12th stage)	
General Survey	1.Tidal Currents		13 ——— 30					
	2.Current Distribution		10 (3rd stage) ———	——— 14				
	3.Buoy Tracking			10-12				
	4.Current Velocity and Turbidity		10 (3rd stage) ———	——— 14				
	5.Bottom Material, Salinity and SS		17-20					
Others	1.Echo-sounding in Wide Area	1 ——— (1st stage)	———	———	——— 15; 18 ———	——— (2nd stage)	——— 1	
	2.Soil Boring				20 ———	——— 20		
	3.Seabed Level			13-14 (1st stage)	1-2 (2nd stage)		6 (3rd stage)	
Remarks	Dredging Works	1 Dredging Work Stop	———	——— 29	————	————	———— 1	

4

3. Items of Survey

Natural Condition Survey was consisted of Yearlong Survey, Monthly Survey, General Survey and Others Survey and items of each survey were as follows ;

3.1 Yearlong Survey

3.1.1 Tides
3.1.2 Wind
3.1.3 Wave

3.2 Monthly Survey

3.2.1 River Discharge
3.2.2 Saline Wedge
3.2.3 Bottom Material
3.2.4 Echo-sounding in Narrow Area

3.3 General Survey

3.3.1 Tidal Currents
3.3.2 Current Distribution
3.3.3 Buoy Tracking
3.3.4 Current Velocity and Turbidity
3.3.5 Bottom Material, Salinity and Suspended Solids

3.4 Others

3.4.1 Echo-sounding in Wide Area
3.4.2 Soil Boring
3.4.3 Seabed Level
3.4.4 Bottom Sampling

3.5 Existing Data

4. Method of Natural Condition Survey

4.1 Yearlong Survey

4.1.1 Tides

1)Method

Tide observation was carried out continuously for one(1) year at the pilot station where located in the mouth of Barito River by using a self-recording type tide gauge (LFT-III).

The method of installation for the tide gauge was shown in Fig. 4.1-1. The tide gauge was consisted of the well of a float senser and a pipe made of vinyl chloride.

A datum level of tide gauge was determined basing upon the bench mark(+3.346m from L.W.S.) which was made by Dredging Enterprise beneath of the tower at pilot station.

The condition of the operation was checked every day and the replacement of recording chart was carried out with about a month interval.

On the other hand, tidal level in the offshore was determined by the average value of water depth obtained continuously by 0.5 second interval for one minutes burst every two hours by using wave height recorder(Ref."4.1.3 Wave") which was installed at St.1 where located at offshore end of the access channel.

2)Position

The position of observation was shown in Fig.4.1-2.

3)Equipment/Goods

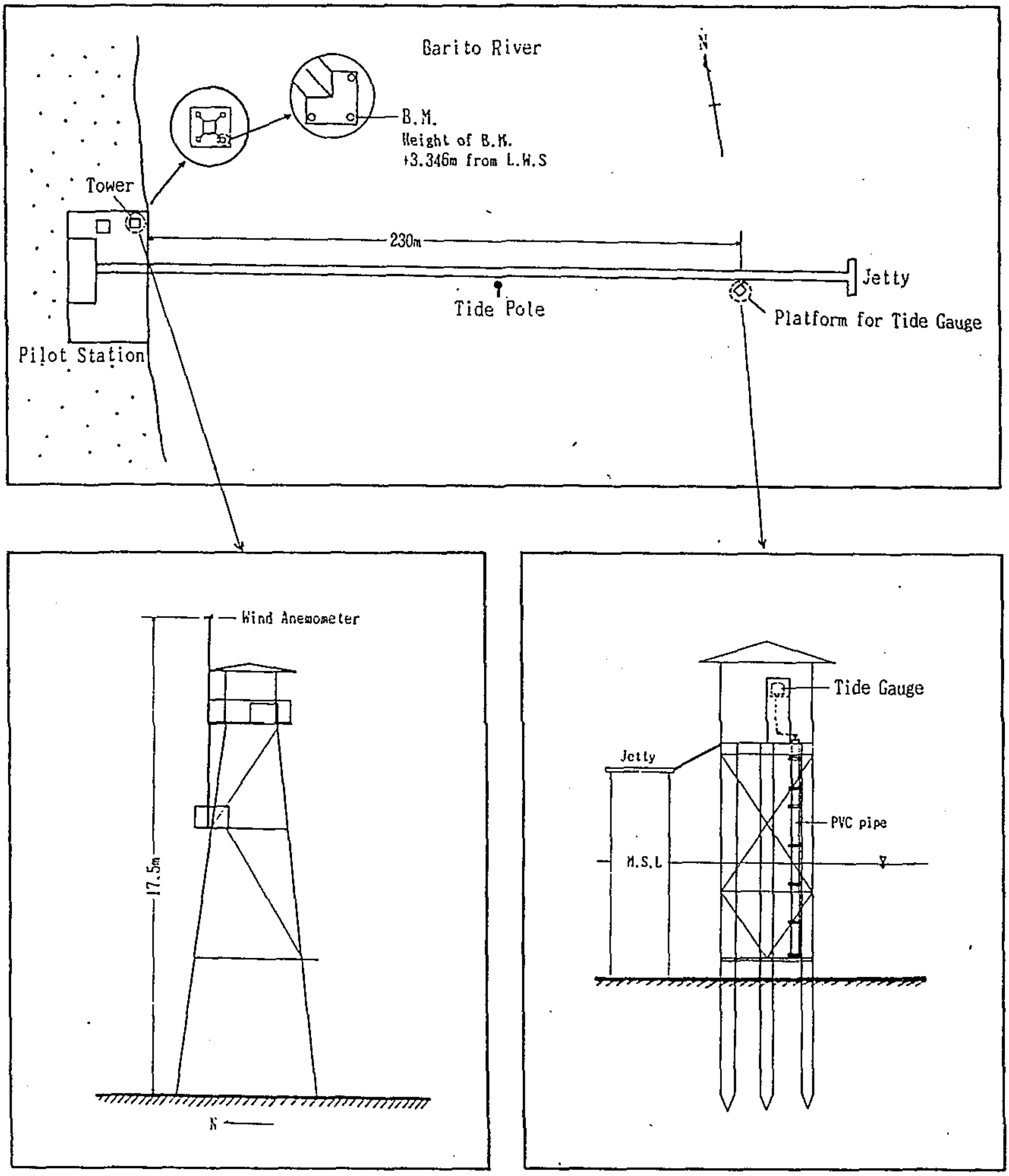
Equipment and Goods were listed in Table 4.1-1.

4)Data Processing

Tidal level at pilot sation was made by tidal level every one hour on the recording paper of tide gauge.
Tidal curve for one year and harmonic analysis were made basing upon tide data at pilot station and St.1.

Table 4.1-1 List of Equipment and Goods for Tide Gauge

Equipment Name	Type	Manufacturer	Number
Fuess Type Tide Gauge	LFT-III	Kyowa Shoko	1
Accessories & Consumable	-	-	-
Set-up Goods	-	-	-



Installation of Wind Anemometer

Installation of Tide Gauge

Fig. 4.1－1　Index Map for Tide Gauge and Wind Anemometer at Pilot Station

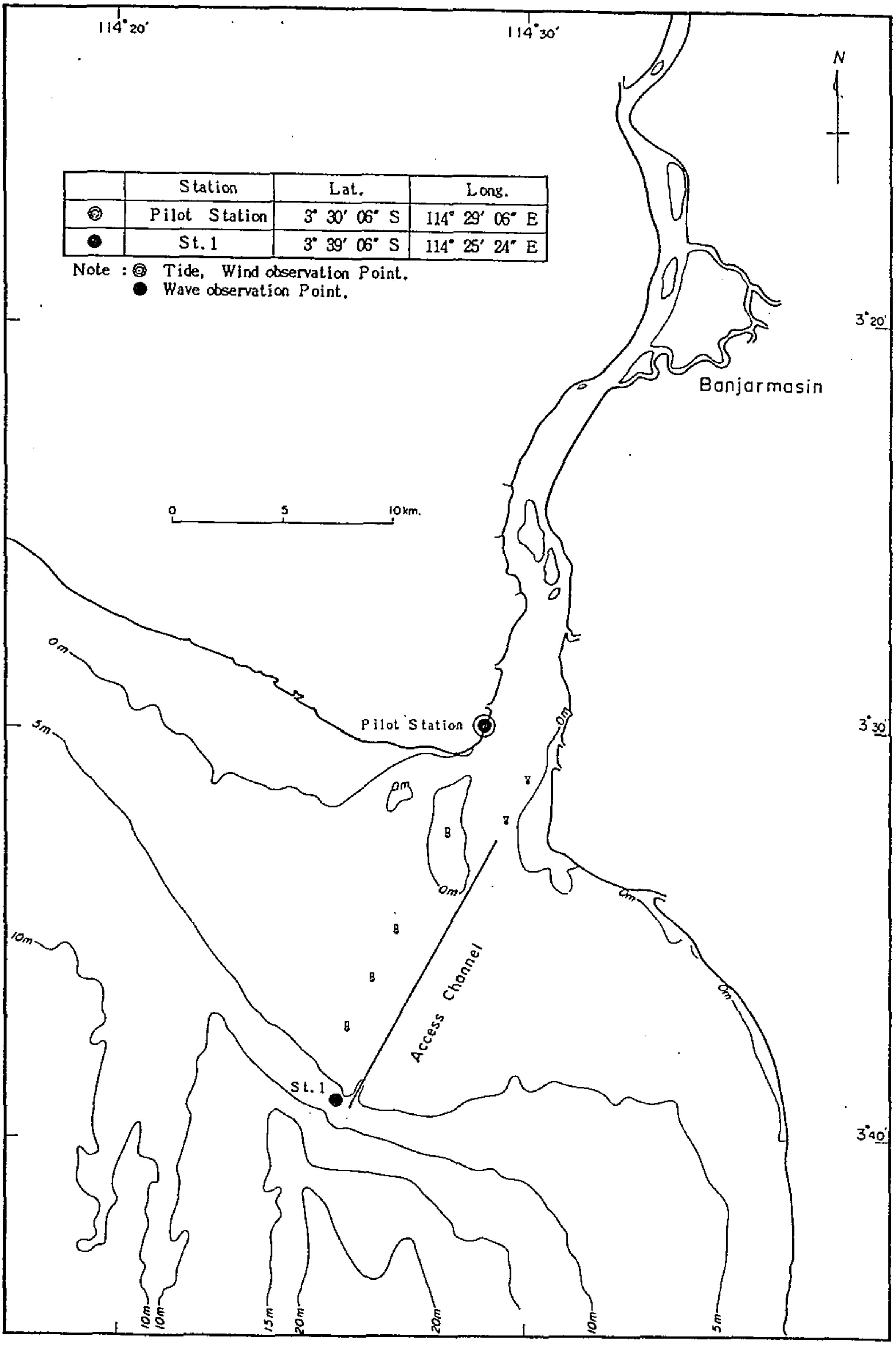


Fig. 4.1−2 Tide, Wind and Wave Observation Points

4.1.2 Wind

1)Method

Wind observation was carried out continuously for one(1) year at the pilot station where located in the mouth of the Barito River by using a self-recording type anemometer.

The method of installation was shown in Fig.4.1-1.

The observational items were as follows ;

- Instantaneous wind velocity for every a hour
- Mean wind velocity 10 minutes duration in one hour interval
- Instantaneous wind direction for every a hour

The replacement of recording chart for anemometer was carried out with a month interval.

2)Position

The position of observation was shown in Fig.4.1-2.

3)Equipment/Gooods

Equipment and Goods were listed in Table 4.1-2.

4)Data Processing

Recording paper of wind meter drew instantaneous velocity, mean velocity for ten minutes and intantaneous direction. These data were read every one hour on the recording paper.

Wind data were calculated and processed for vector and frequency distribution of wind velocity by wind direction. On the processing, wind velocity means mean wind velocity for ten minutes and wind direction means instantaneous wind direction.
Wind direction in the vector was converted to "direction in wind run away" same as "direction in current run away" due to grasping easily the image between wind and current.

Table 4.1-2 List of Equipment and Goods for Wind Observation

Name of Equipment	Type	Manufacturer	Number
Wind Direction and Wind Speed Anemometer	KDD-300	Koshin Denki	1
Accessories & Consumable	KDD-300	Kosin Denki	1
Set-up Goods	-	-	1

4.1.3 Wave

1)Method

Wave height and wave direction were observed continuously through one(1) year by using a self-recording wave height recorder(SSW-II) and a electromagnetic current meter (EMC-108).
The method of installation was shown in Fig. 4.1-3.

The conditions of observation were as follows ;

* Wave height

Measurement interval	:	2 hours
Measurement burst duration	:	8 min. 31 sec
Number of data	:	1022
Sampling interval	:	0.5 sec

* Wave direction

Measurement interval	:	2 hours
Measurement burst duration	:	4 min. 16 sec
Number of data	:	512
Sampling interval	:	0.5 sec

The replacement of cassette tape for the record was at an interval of 14 days for both equipment. When both equipment were withdrawn from undersea, divers were employed.

The installed condition of both equipment were checked at an interval of 7 days by divers.

2)Position

The position of observation was shown in Fig.4.1-2.

Water depth of the position was 9.1m of L.W.S at pilot station.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.1-3.

4)Data Processing

* Wave Height and Period

Wave height and period were made by Zero-up cross method through the folowing process.
Continuous water depths input in the cassette tape of wave height meter were read and converted to format by an exclusive tape reader(TEAC MT-2GP) with personal computer.

Elements of Wave data for one year and monthly were obtained by results of statistic analysis.

* Wave Direction

Dominant wave direction is an averaged direction which is able to be calculated indirectly from meaurement of movement of water particle on the orbit of wave motion.
That is continuous data of current velocity(X-comp.,Y-comp.) and current direction input in the magnetic tape of electro -magnetic currentmeter were converted to N-comp. E-comp, velocity and direction.
After then elements of dominant wave direction and oscillatory flow are calculated.

Table 4.1-3 List of Equipment and Goods for Wave Observation

Equipment Name	Type	Manufacturer	Number
Supersonic Magnetic Reading Type Wave Height Recorder	SSW-II	Kyowa Shoko	2
Accessories & Consumable	SSW-II	Kyowa Shoko	2
Electromagnetic Current Meter	EMC-108	Yokogawa	1
Accessories & Consumable	EMC-108	Yokogawa	1
Mooring Goods	-	-	1

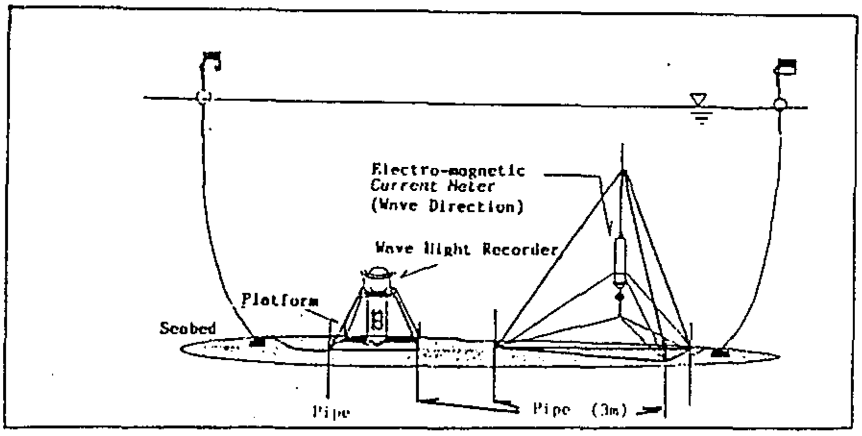


Fig. 4.1-3 Wave Observation Method

4.2 Monthly Survey

4.2.1 River Discharge

1)Method

This observation was carried out on a line of a transverse section of the Barito River. Prior to start the observation, water depth was measured along the line by a Echo-sounding and five(5) observational points were established.

A vertical distribution of profile of current was observed by using a direct-reading type current meter(DCM-PRT-III).

A vertical distribution of profile of salinity and water temperature was observed by using a direct-reading type salinometer(EIL).

A vertical distribution of profile of turbidity was observed by using a direct-reading type turbid meter(PT-1).

SS was calculated basing upon value obtained from measurement of specific gravity of sample by using hydrometer.

The conditions of observation were shown in the following table.

Number of Points	Period	Interval	Observational Layer
5	24 hours	1 hour	every 1m below surface and 0.5m above seabed

A survey boat was fixed by anchor at each point, and the observations mentioned above was carried out as shown in Fig. 4.2-1.

This observation was carried out before or after a Saline Wedge observation.

2)Position

The positions of observation were shown in Fig. 4.2-2.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.2-1.

4)Data Processing

River Discharge Volume was obtained by following procedure.

- Before commencement of survey in each stage, river profile was divided at intermediate point between both stations for horizontal line and at intermediate layer for each observational layer for vertical line.
- Current direction and velocity corresponded to each devided section were converted to a direction of principal river axis (Principal axis set 220 deg. from mag.N).
- River discharge volume was obtained from to multiply the velocity which was projected to the direction of principal river axis and square of the divided section.

Thus distribution of each survey items in profile was made by results about the projected velocity(X-comp), water temperature, salinity and turbidity.

Table 4.2-1 List of Equipment and Goods for Saline Wedge

Equipment Name	Type	Manufacturer	Number
Direct Reading Flow Direction Current Meter Printer	DCM-PRT-III	Kyowa Shoko	5
Salinometer	EIL	Kawamura Tsusho	5
Turbidmeter	PT-1	Alec Denshi	5
Water Sample	Van-Dorn		5

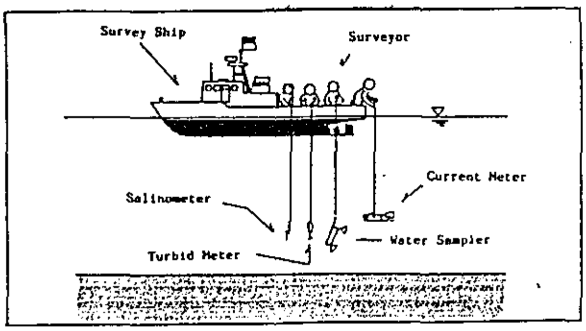


Fig. 4.2-1 River Discharge Survey Method

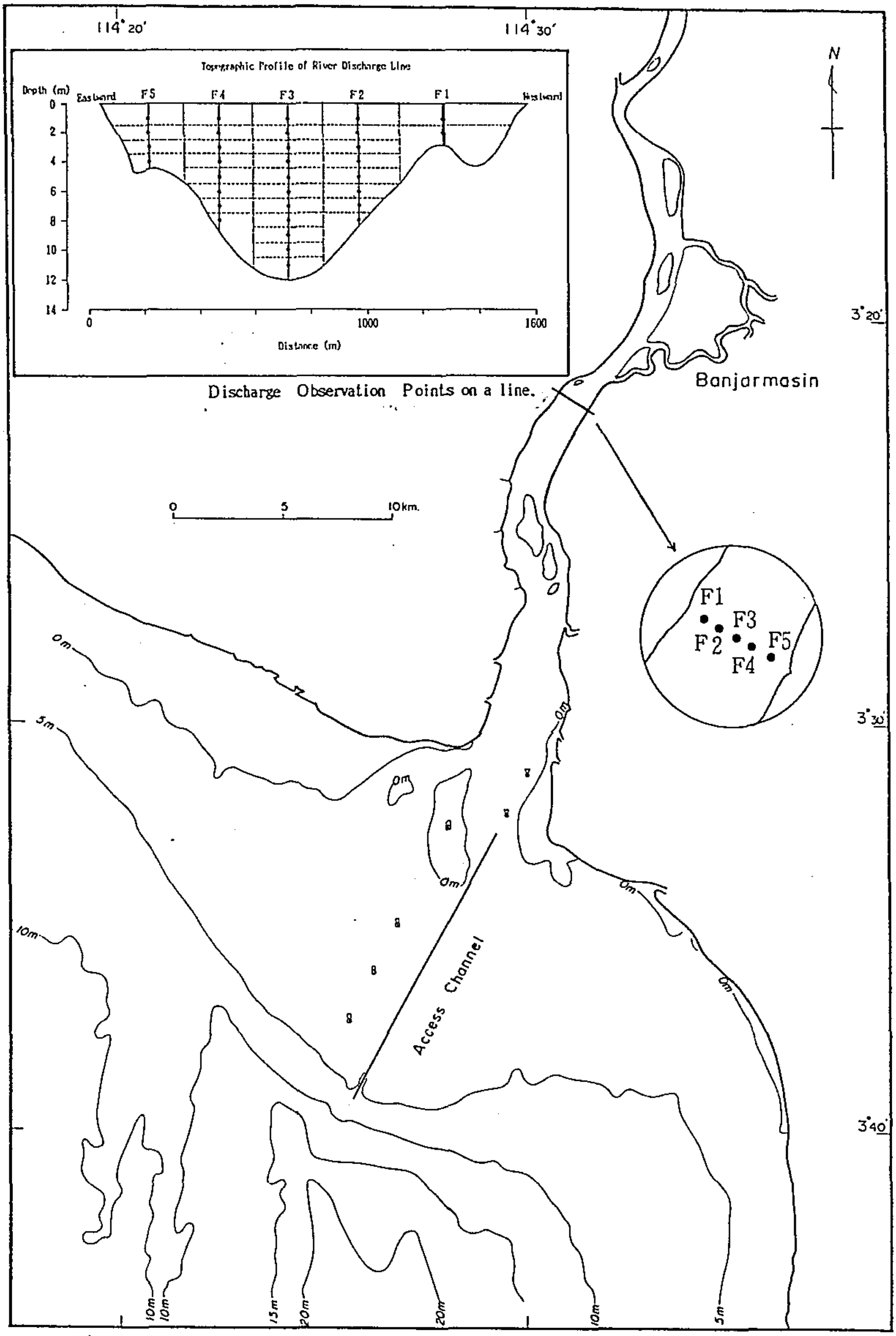


Fig. 4.2－2 Discharge Survey Points

4.2.2 Saline Wedge

1)Method

A vertical distribution of profile of current was observed by using a direct-reading type current meter(DCM-PRT-III).

A vertical distribution of profile of salinity and water temperature was measured by using a direct-reading type salinometer(EIL).

A vertical distribution of profile of turbidity was measured by using a direct-reading type turbid meter(PT-1).

SS was calculated basing upon value obtained from measuremnt of specific gravity of sample by using hydrometer.

The conditions of observation are shown in the following table.

Number of Points	Period	Interval	Observational layer
8(dry season) 8(rainy season)	24 hours	1 hour	-every 1m pitch from surface to 2m above seabed -every 0.5m pitch from seabed to 2m above seabed

A survey boat was fixed by anchor at each point and the observations mentioned above were carried out as shown in Fig. 4.2-3.

2)Position

The positions of observation were shown in Fig. 4.2-4.

3)Equipment/Goods

Equipments and Goods were listed in Table 4.2-2.

4)Data Processing

From results of each survey item, water temperature, salinity, turbidity and current velocity(X-comp.) in a direction of river principal axis in time series were made.

Table 4.2-3 List of Equipment and Goods for Saline Wedge

Equipment Name	Type	Manufacturer	Number
Direct Reading Flow Direction Current Meter Printer	DCM-PRT-III	Kyowa Shoko	5
Salinometer	EIL	Kawamura Tsusho	5
Turbidmeter	PT-1	Alec Denshi	5
Water Sampler	Van-Dorn		5

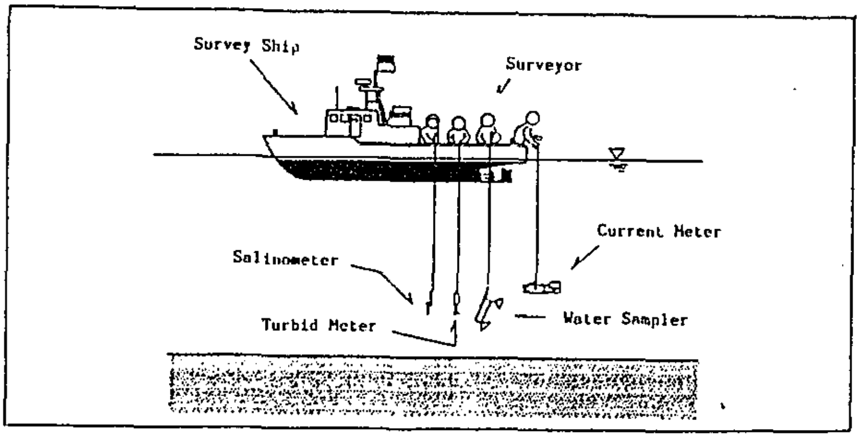


Fig. 4.2-3 Saline Wedge Survey Method

Station	Lat.	Long.	Duration	*
A	3° 38′ 22″ S	114° 26′ 14″ E	◉	208°
B	3° 35′ 30″ S	114° 27′ 45″ E	◉	208°
C	3° 32′ 42″ S	114° 29′ 20″ E	◉	190°
D	3° 31′ 23″ S	114° 29′ 34″ E	◉	190°
E	3° 29′ 17″ S	114° 30′ 00″ E	◉	190°
F	3° 22′ 30″ S	114° 30′ 30″ E	◉	220°
G	3° 21′ 00″ S	114° 32′ 20″ E	○	225°
H	3° 16′ 00″ S	114° 33′ 00″ E	○	155°
I	3° 37′ 00″ S	114° 27′ 00″ E	●	208°
J	3° 34′ 10″ S	114° 28′ 33″ E	●	208°

Note 1: * Dir. of River Principal Axis
Note 2: ◉ Rainy & Dry Season
● Rainy Season
○ Dry Season

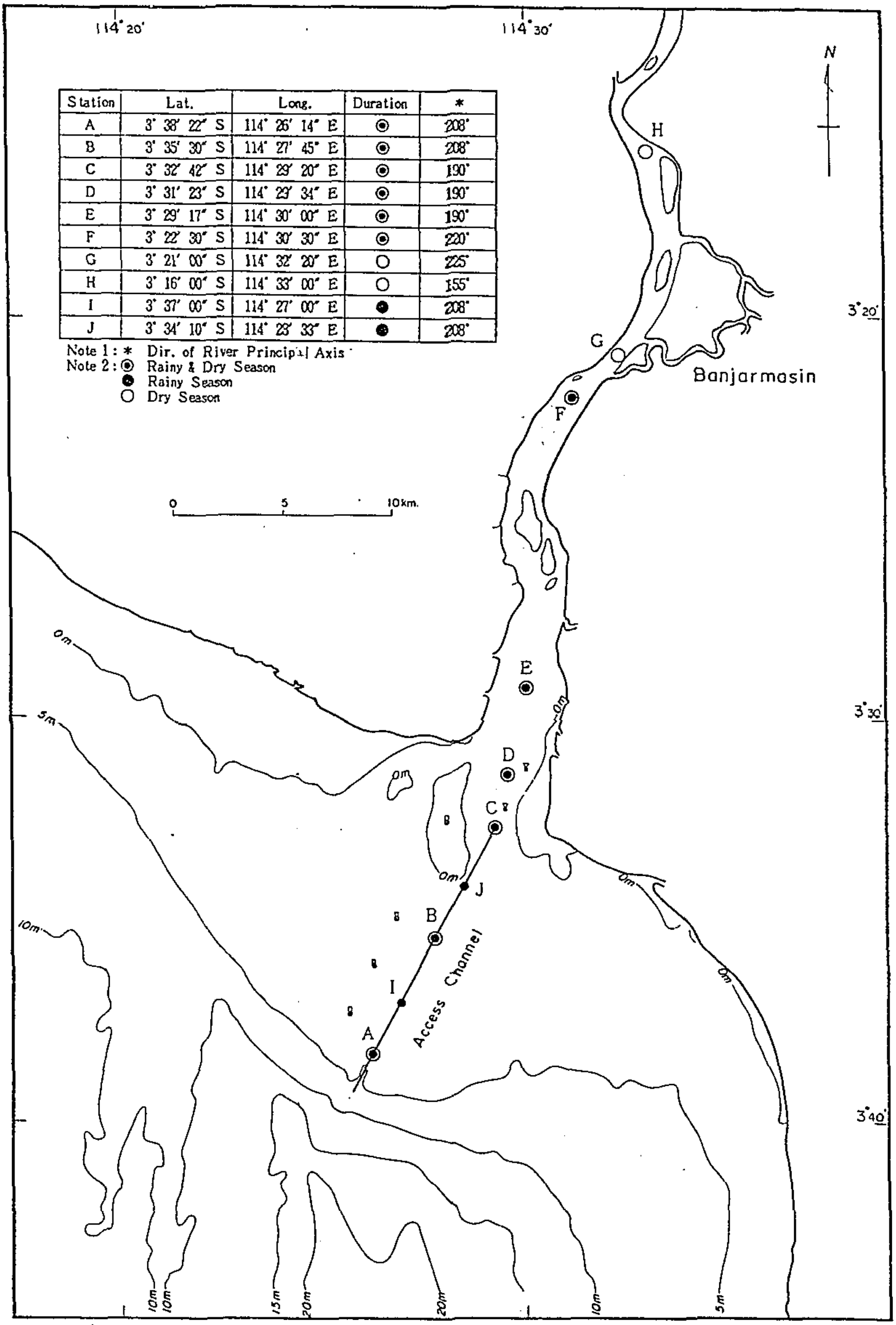


Fig. 4.2－4 Saline wedge Survey Points

4.2.3 Bottom material

1)Method

Bottom material was taken at each point by using a grab type bottom sampler as shown in Fig. 4.2-5.

Vane test was carried out onboard by using a handy type vane test equipment.

Depth was measured by using a lead line.

2)Position

The positions of bottom sampling were similar in river Discharge and Saline Wedge observation as shown in Fig. 4.2-2 and Fig. 4.2-4.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.2-3.

4)Data Processing

Bottom materials sampled were analyzed about following items and list and distribution map were made.

- Vane Test
- Grain Distribution
- Natural Water Content
- Ignition Loss
- Specific Gravity
- Cumulative Curve of Grain Size

Table 4.2-3 List of Equipment and Goods for Bottom Material

Equipment Name	Type	Manufacturer	Number
Bottom Sampler	Grab Type		1
Handy Vane Test Equipment			5
Sample Bottle for Bottom Material	1 l		160
Lead line	2.7 Kg		5

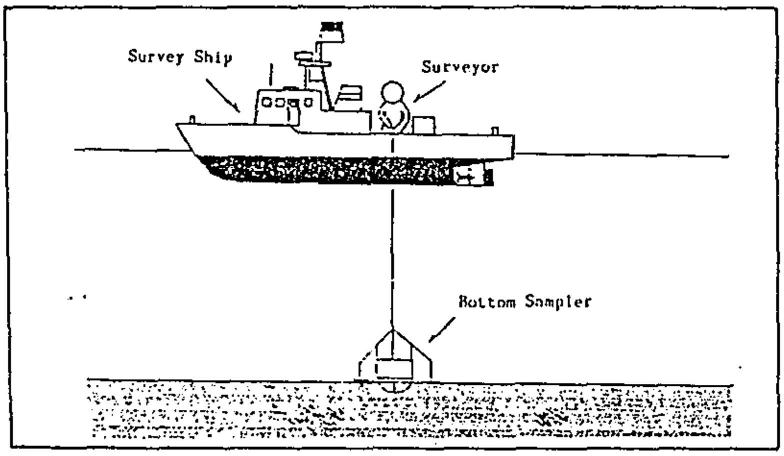


Fig. 4.2-5 Bottom Material Sampling Method

4.2.4 Echo-sounding in Narrow Area

1)Method

Echo-sounding was carried out using an echo-sounder(ATLAS DESO 10, Frequency: 210kHz and 33 kHz) in the area of access channel as shown in Fig. 4.2-6.

Sounding lines were set every an interval of 25m transverse to the access channel.

Tide corrections was made on the obtained depths, using observational tide data at the pilot station.

Sound velocity corrections was made for the obtained depths by the bar-check method.

2)Area

The sounding area (0.3km x 15km) was shown in Fig. 4.2-7.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.2-4.

4)Data Processing

Following figures were drawn from results of Echo-sounding in Narrow area.

- Tracking Charts (Scale : 1/2500)
- Bathymetric Chart (Scale : 1/2500)
- Contour Chart (Scale : 1/2500)
- Longitudinal Section (Center line , East side 50m, East side 100m of center line, West side 50m, West side 100m of center line)
- Transverse Section(Total 28 lines with 500m interval)

Table 4.2-4 List of Equipment and Goods for Echo-sounding

Equipment Name	Type	Manufacturer	Number
Echo-sounder	ATLAS DESO 10		1
Check Bar			1
Accessories & Consumable			1

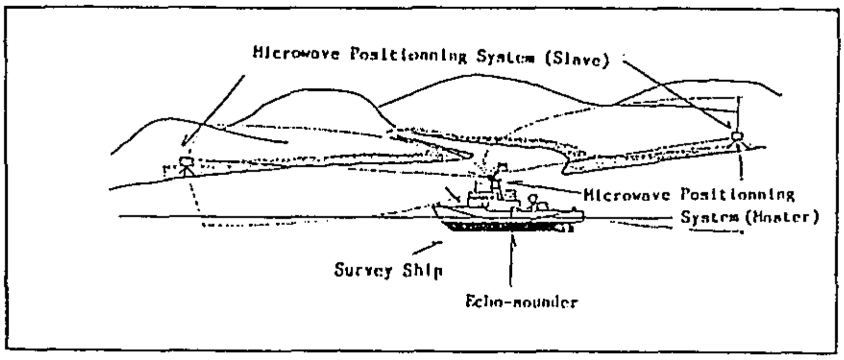
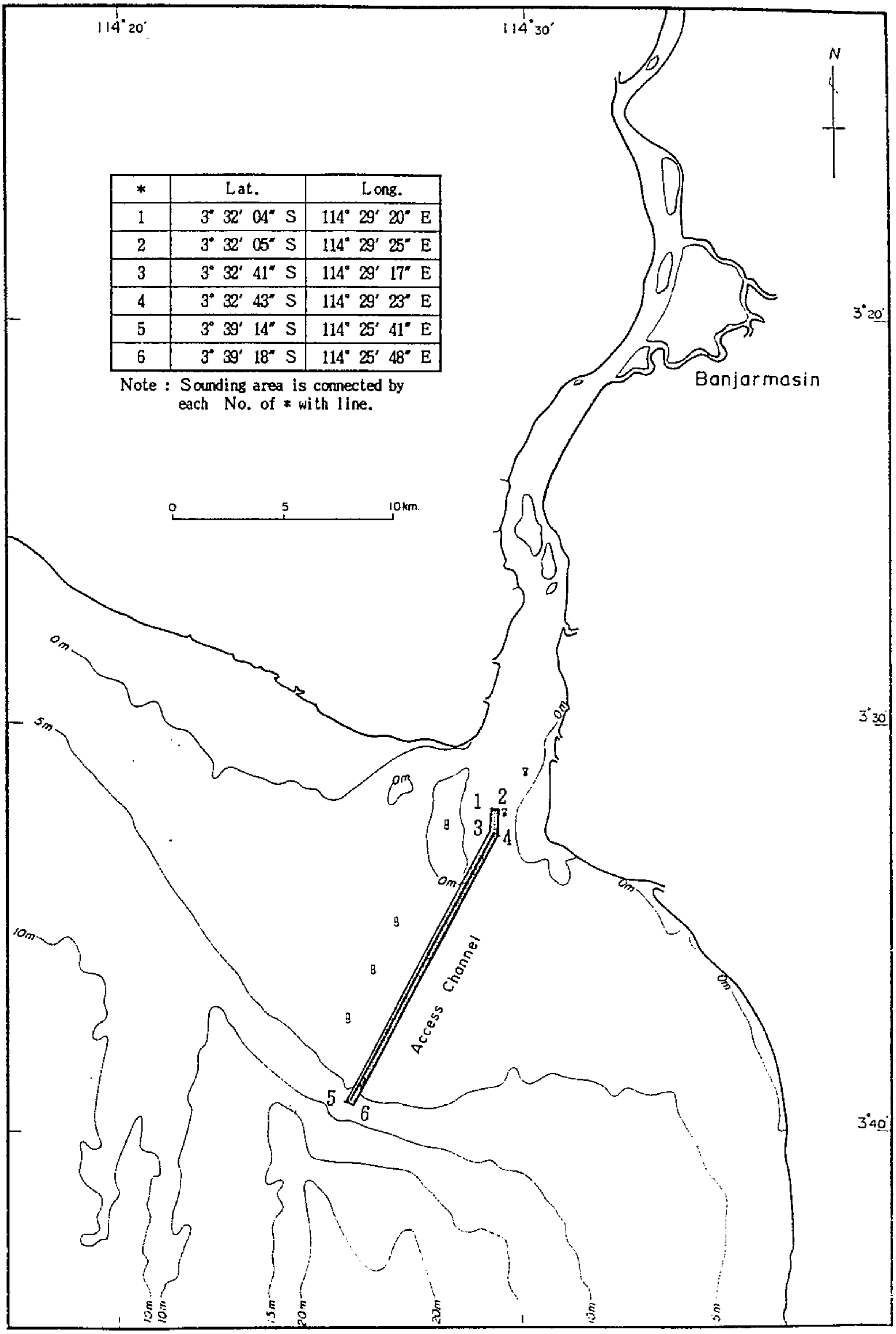


Fig. 4.2-6 Echo-sounding Method in Narrow Area



*	Lat.	Long.
1	3° 32' 04" S	114° 29' 20" E
2	3° 32' 05" S	114° 29' 25" E
3	3° 32' 41" S	114° 29' 17" E
4	3° 32' 43" S	114° 29' 23" E
5	3° 39' 14" S	114° 25' 41" E
6	3° 39' 18" S	114° 25' 48" E

Note : Sounding area is connected by each No. of * with line.

Fig. 4.2－7 Echo-Sounding Area in Narrow Area

4.3 General Survey

4.3.1 Tidal Currents

1)Method

Tidal current was observed by using self-recording current meters(MTC-III).

The conditions of measurement were shown in the followimg table.

Number of Points	Period	Measurement Interval	Observational Layer
2	15-day and night	every 10 minutes	3m above seabed

The current meters were installed as shown in Fig. 4.3-1.

The installed condition of the current meter was checked in every day during the observational period.

2)Position

The positions of observation were shown in Fig. 4.3-2.

3)Equipment/Goods

Equipments and Goods were listed in table 4.3-1.

4)Data Processing

Current velocity and direction input cassette tape in self-recording currentmeter were read and converted to format by using an exclusive tape reader (TEAC MT-2GP) and personal computer.

Current curve, frequncy distribution of current velocity by direction, tidal harmonic constant and tidal ellipses were made by using the abovementioned data.

Table 4.3-1 List of Equipment and Goods for Tidal Current

Equipment Name	Type	Manufacturer	Number
Self-recording Current Meter	MTC-III	Kyowa Shoko	2
Accessories & Consumable	MTC-III	Kyowa Shoko	2
Mooring Goods	-	-	2

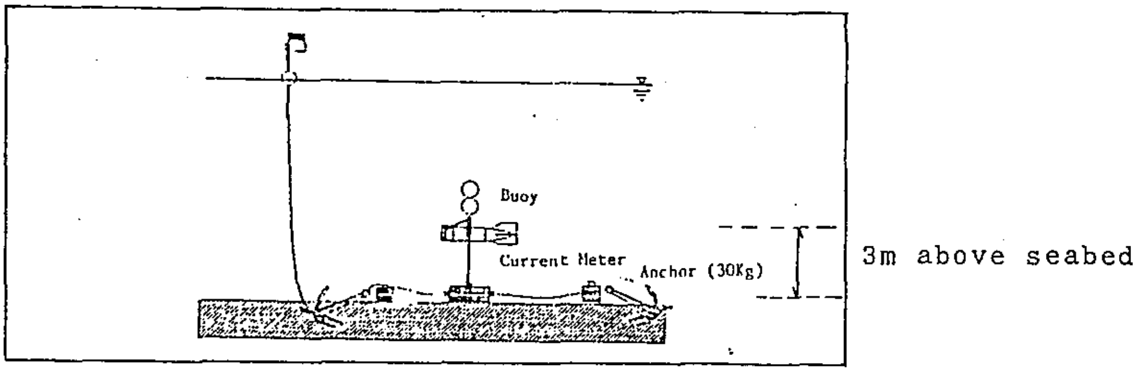
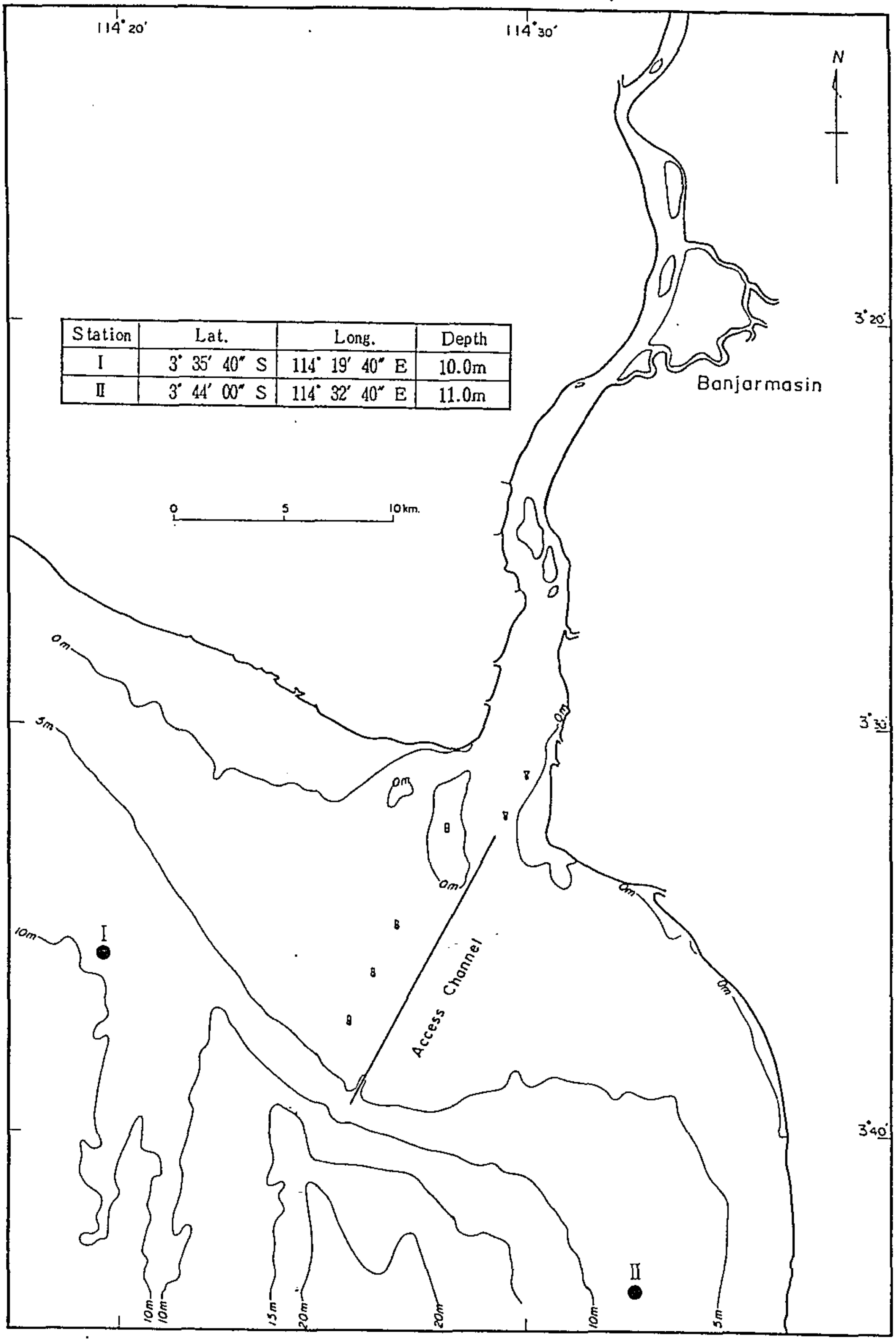


Fig. 4.3-1 Tidal Currents Survey Method



Station	Lat.	Long.	Depth
I	3° 35' 40" S	114° 19' 40" E	10.0m
II	3° 44' 00" S	114° 32' 40" E	11.0m

Fig. 4.3－2　Tidal Current Survey Points

4.3.2 Current Distribution

1)Method

Current was observed by using an electromagnetic current meter(EMC-108).

The conditions of measurement were shown in the following table.

Number of Points	Period	Interval of Measurement	Duration of Measurement	Observational Layer
11	30 day and night(⊕) 15 day and night(○)	every 60 minutes	2 min. 8 sec	0.5m above seabed

The current meters were installed on the seabed as shown in Fig. 4.3-3 by divers and withdrawn by divers after the completion of observation.

The replacement of magnetic tape for the record was carried out with an interval of 15 day and night.

The installed condition of the current meter was checked every day by divers.

2)Position

The observational positions and period were shown in Fig. 4.3-4.

3)Equipment/Goods

Equipment and Goods were listed in table 4.3-2.

4)Data Processing

Continuous data for current velocity(X-comp.Y-comp.)every 0.5 sec and current direction input in casset tape of electromagnetic currentmeter were read and converted to format by an exclusive tape reader(EX010). After then value of current velocity, N-comp. and E-comp. were obtained.
From the these results, the velocity and direction every one hour were calculated and currnet curve,frequency distribution of current velocity by direction, tidal harmonic constant and current ellipse were made.
And elements of oscillatory flow in time series were made by the calculated results of oscillatory flow every one hour.

Table 4.3-2 List of Equipment and Goods for Current 1

Equipment Name	Type	Manufacturer	Number
Electromagnetic Current Meter	EMC-108	Yokogawa	9
Accessorioes and Consumable	EMC-108	Yokogawa	9
Mooring Goods	-	-	9

Table 4.3-3 Water Depth of Currentmeter Installed

St.	1st stage	2nd stage	3rd stage
2	1.3m	1.3m	1.4m
3	0.6	0.8	0.9
4	0.6	1.0	0.9
5	0.7	0.7	0.9
6	1.4	1.2	1.3
7	1.4	1.1	1.3
8	0.6	0.5	0.7
9	0.8	0.9	0.8
10	2.3	2.2	2.2
11	1.0	0.9	0.8

Note: Water depth measuerd from L.W.S at Pilot Station.

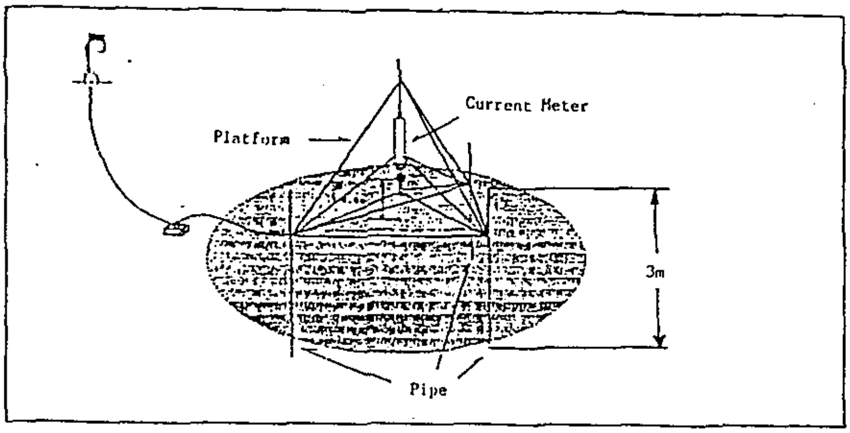


Fig. 4.3-3 Current Distribution Survey Method

Station	Lat.	Long.	Duration
1	3° 39' 06" S	114° 25' 22" E	●
2	3° 36' 15" S	114° 26' 48" E	●
3	3° 34' 22" S	114° 27' 48" E	●
4	3° 32' 25" S	114° 28' 53" E	●
5	3° 32' 30" S	114° 29' 42" E	●
6	3° 37' 33" S	114° 29' 10" E	⊙
7	3° 35' 50" S	114° 25' 23" E	○
8	3° 33' 34" S	114° 26' 24" E	○
9	3° 36' 45" S	114° 27' 44" E	●
10	3° 34' 54" S	114° 28' 46" E	⊙
11	3° 35' 38" S	114° 30' 11" E	⊙

Note 1 : ● 30 days,
○ 15 days (1st half month)
○ 15 days (2nd half month)
Note 2 : Position from St. 2 ~ St. 11 in Lat. and Long. shows the planed positions.

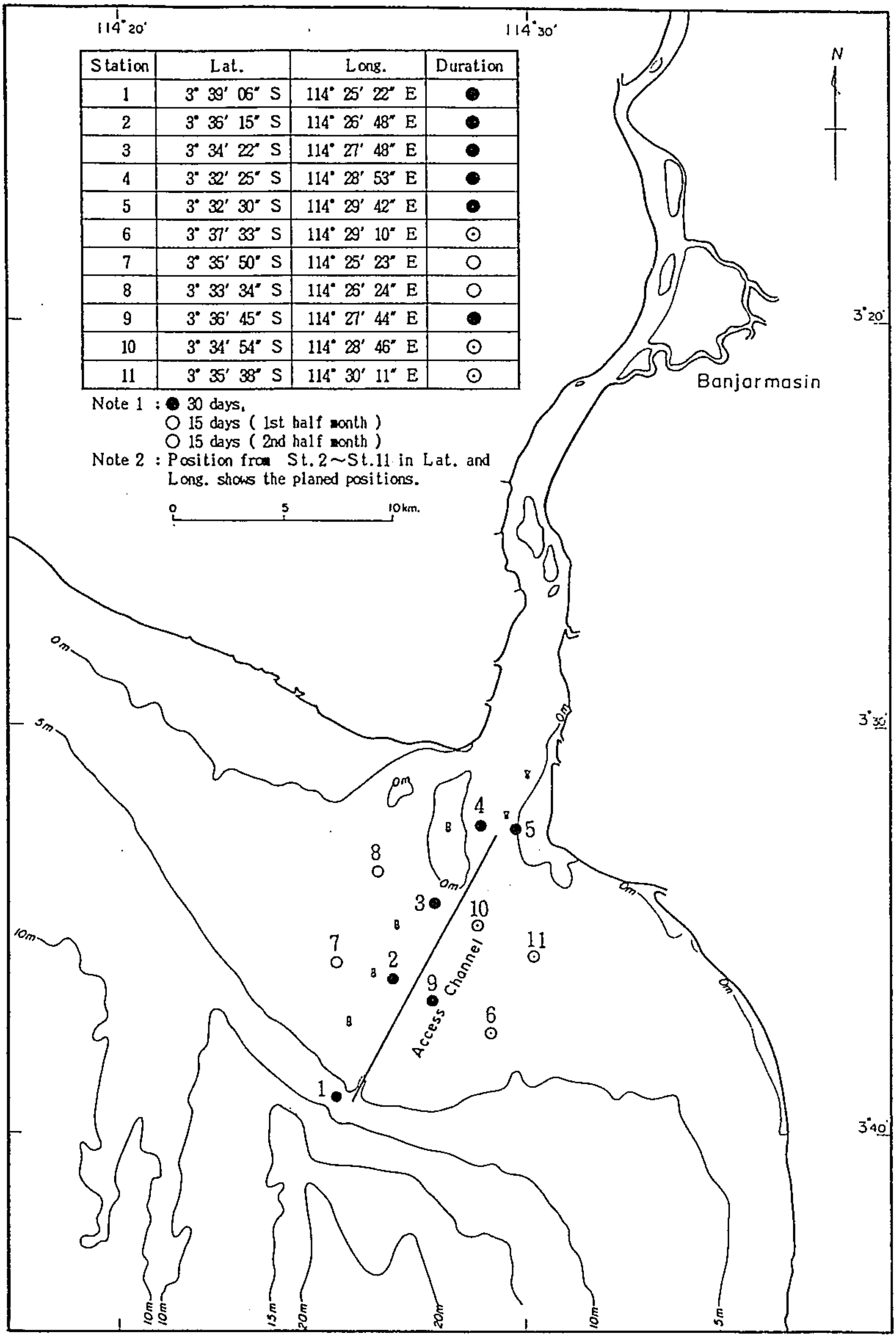


Fig. 4.3－4 Current Distribution Survey Points

4.3.3 Buoy Tracking

1)Method

Current observation in buoy tracking survey at the mouth of the Barito River was conducted by tracking floats as shown in Fig. 4.3-5.

The condition of this observation were shown in the following table.

Number of Boats	Number of Floats	Interval of Positioning	Period
4	12	every 15 minutes	3 days(8 hour/day)

2)Start point

The start points of this observation were shown in Fig. 4.3-6.

3)Equipment/Goods

Floats were shown in Fig. 4.3-5.

4)Data Processing

Following charts were drawn by results of buoy tracking survey.

- Bouy Tracking Chart (Scale : 1/20000)
- Current Vector Chart(Scale : 1/20000)

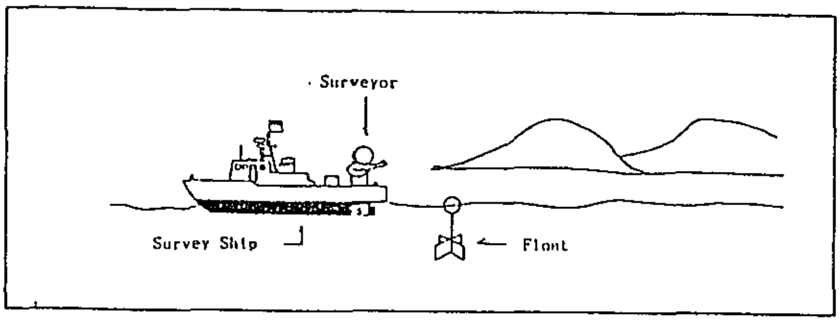


Fig. 4.3-5 Buoy Tracking Survey Method

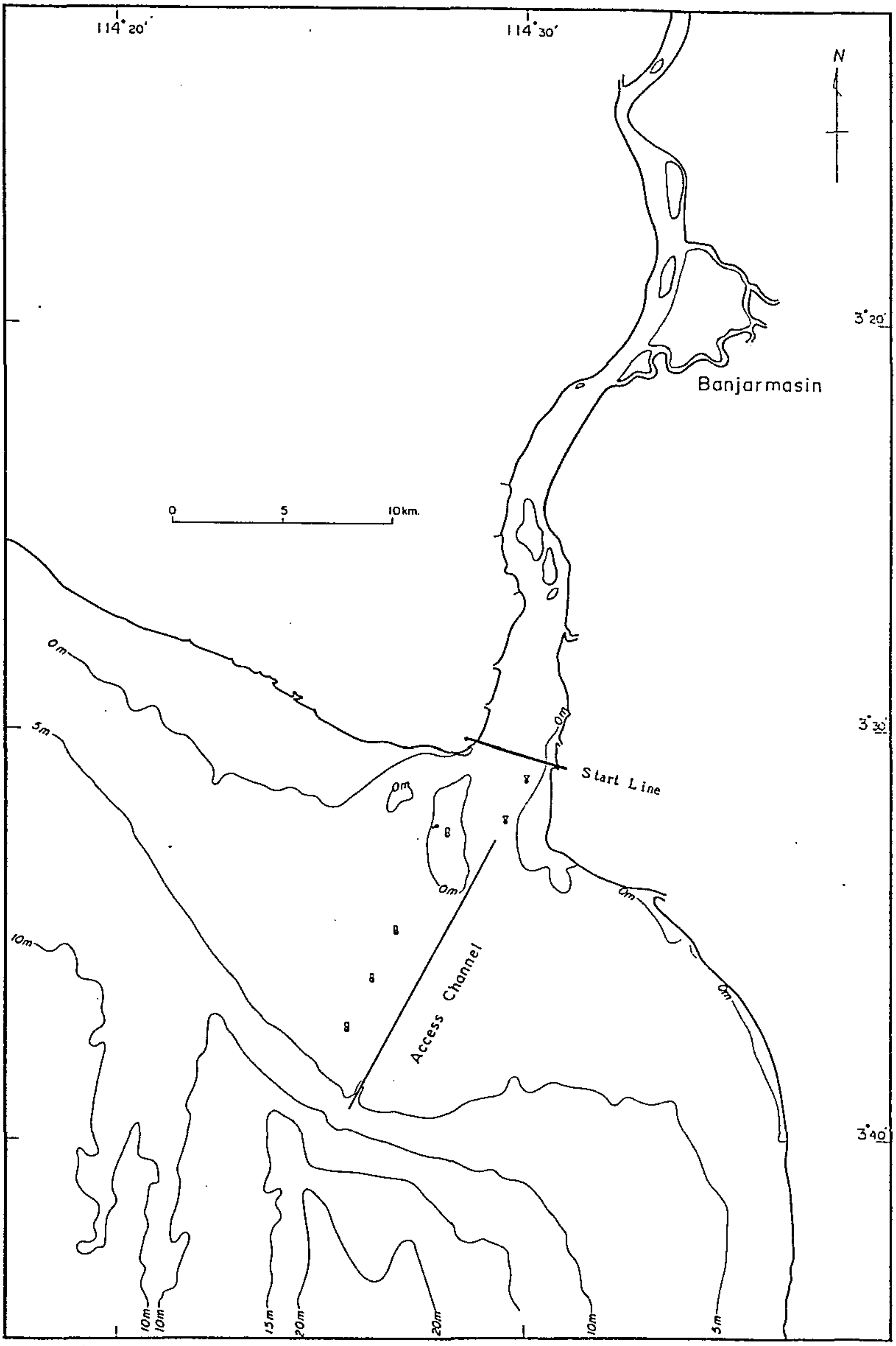


Fig. 4.3 - 6 The Start Line of Buoy tracking Survey

4.3.4 Current Velocity and Turbidity

1)Method

·A vertical distribution of profile of current was observed by using a direct-reading type current meter(DCM-PRT-III).

A vertical distribution of profile concentration of suspended solids(S.S.) were measured by water sampling which was taken by a water sampler.

The sedimentation velocity of S.S. were measured by using Owen Tube(Observation layer was 0.5m above seabed).

The conditions of measurement were shown in the following table.

Number of Points	Number of Times	Observational Layer
30	1	every 0.5m from seabed

A survey boat was fixed by anchor at each point and the observation mentioned above was carried out as shown in Fig. 4.3-7.

2)Position

The positions of observation were shown in Fig. 4.3-8.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.3-3.

4)Data Processing

Figures of vertical distribution of current velocity, direction and the analyzed value of SS of water sample were made at each station.

Analysed value of SS by Owen Tube were listed in data file.

Table 4.3-3 List of Equipment and Goods for Current and Turbidity

Equipment Name	Type	Manufacturer	Number
Water Sampler	Pump Type		2
Sample Bottle for Water	1 l 0.5 l	-	400/time 550/time
Owen Tube	-	Kyowa Shoko	1
Direct Reading Flow Direction Current Meter Printer	DCM-PRT-III	Kyowa Shoko	1

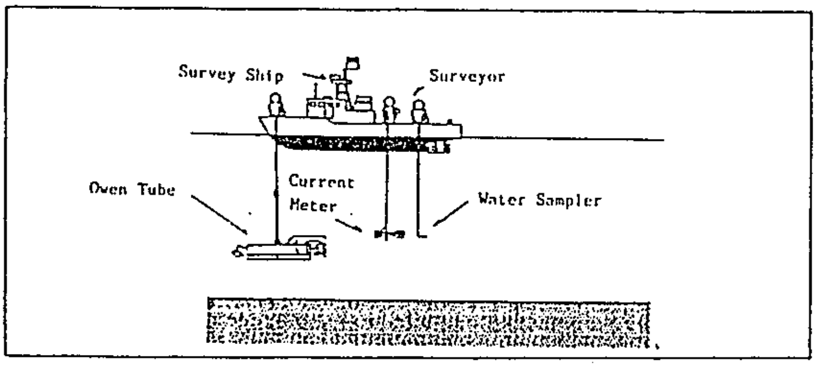


Fig. 4.3-7 Current Velocity and Turbidity Survey Method

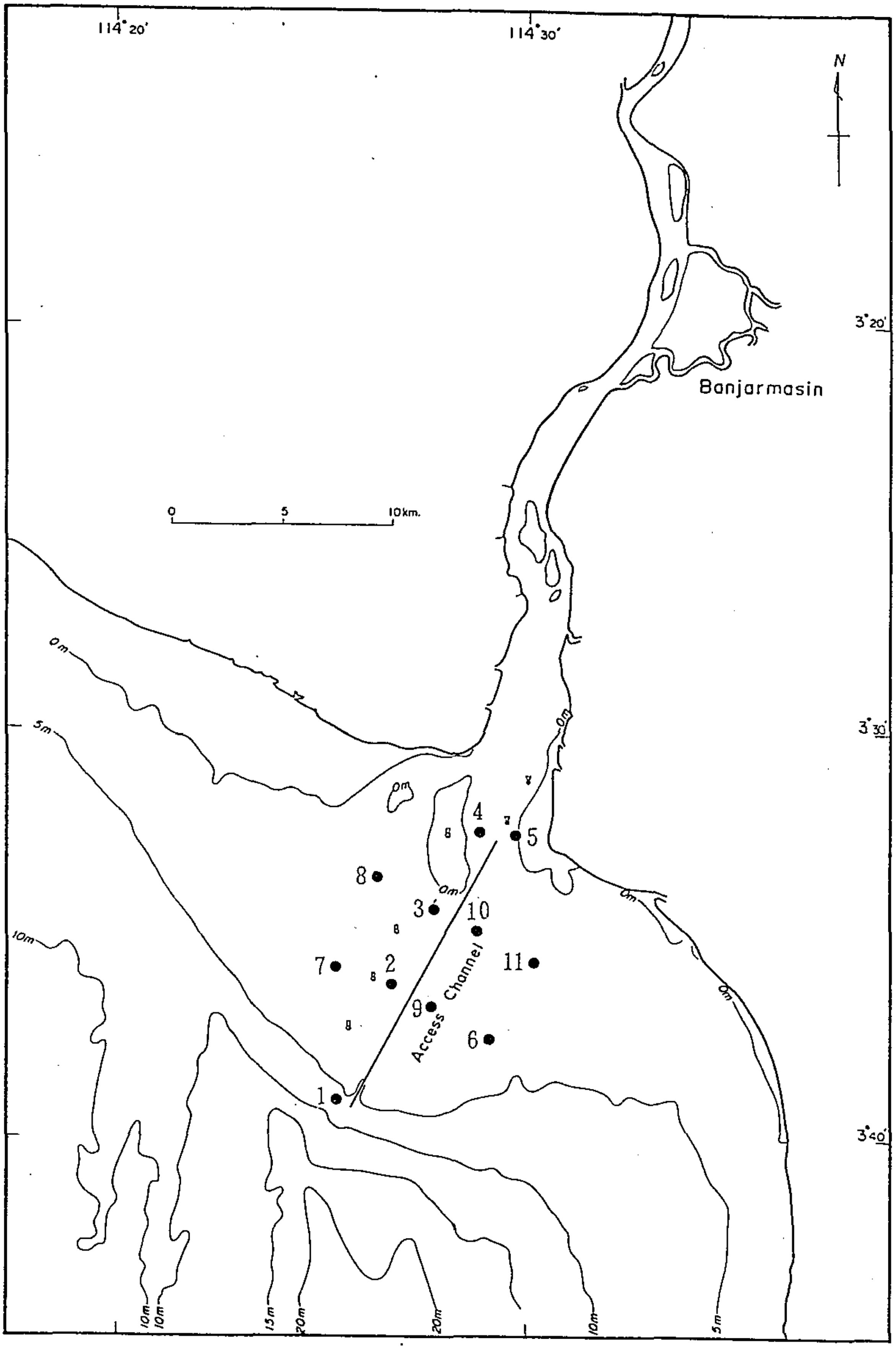


Fig. 4.3－8 Current Velocity and Turbidity Points

4.3.5 Bottom Material, Salinity and Suspended Solids

1)Method

Bottom sampling was carried out by a grab type bottom sampler.

A vertical distribution of profile of salinity was measured by using a direct-reading type salinometer(EIL).

A vertical distribution of profile of density of S.S. was measured by water sampling which was taken by a water sampler.

A depth was measured by a lead line.

The conditions of survey were shown in the following table.

Survey Item	Number of Points	Observational Layer	Note
Bottom Sampling	26	-	Vane test was done onboard
Salinity	26	Surface and 0.5m above seabed	
S.S.	26	Surface and 0.5m above seabed	
Depth	26	-	

A survey boat was fixed by anchor at each point and the observation mentioned above were carried out as shown in Fig. 4.3-9.

2)Position

The positions of survey were shown in Fig. 4.3-10.

3)Equipment/Goods

Equipment and Goods were listed in table 4.3-4.

4)Data Processing

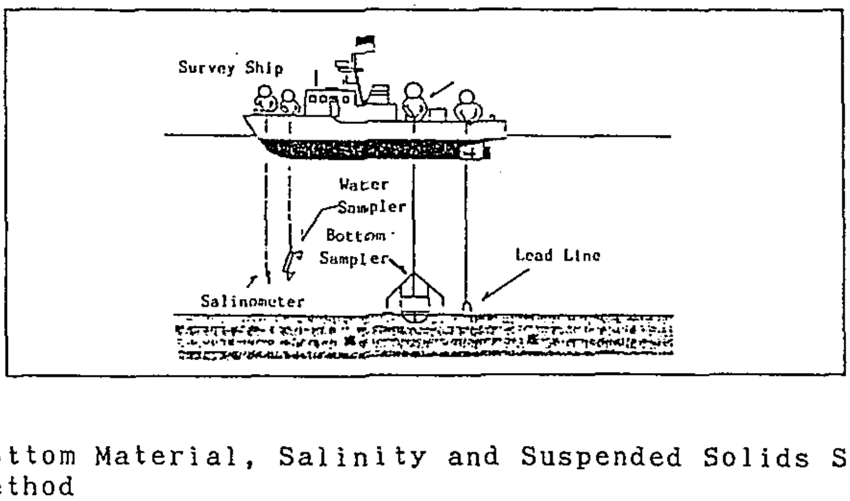
Bottom materials taken by a bottom sampling were analysed about following items and List and Distribution Map were made.

- Vane Test
- Grain Distribution
- Natural Water Content
- Ignition Loss
- Specific Gravity
- Cumulative Curve of Grain Size

Figures of horizontal distribution for water temperature, salinity and ss analysed by water sample were made.

Table 4.3-4 List of Equipment and Goods for Bottom Material, Salinity and Suspended Solids

Equipment Name	Type	Manufacturer	Number
Bottom Sampler	Grab Type		1
Handy Vane Test Equipment	-		1
Lead line	2.7 Kg		1
Salinometer	EIL	Kawamura Tsusho	1
Water Sampler	Van-dorn Type	-	1
Sample Bottle for Bottom Material	1 l	-	120
Sample Bottle for Water	1 l	-	70/time



ig. 4.3-9 Bottom Material, Salinity and Suspended Solids Survey Method

Station	Lat.	Long.	Station	Lat.	Long.
a	3° 29′ 17″ S	114° 30′ 00″ E	n	3° 37′ 53″ S	114° 32′ 03″ E
b	3° 31′ 23″ S	114° 29′ 34″ E	o	3° 35′ 42″ S	114° 24′ 38″ E
c	3° 32′ 25″ S	114° 28′ 53″ E	p	3° 36′ 44″ S	114° 26′ 31″ E
d	3° 33′ 00″ S	114° 29′ 50″ E	q	3° 37′ 28″ S	114° 27′ 30″ E
e	3° 32′ 50″ S	114° 26′ 10″ E	r	3° 38′ 18″ S	114° 29′ 22″ E
f	3° 33′ 57″ S	114° 28′ 05″ E	s	3° 36′ 03″ S	114° 21′ 58″ E
g	3° 34′ 24″ S	114° 29′ 02″ E	t	3° 38′ 07″ S	114° 25′ 44″ E
h	3° 35′ 26″ S	114° 30′ 54″ E	u	3° 38′ 39″ S	114° 26′ 42″ E
i	3° 33′ 12″ S	114° 23′ 32″ E	v	3° 40′ 44″ S	114° 30′ 30″ E
j	3° 34′ 15″ S	114° 25′ 24″ E	w	3° 37′ 06″ S	114° 23′ 52″ E
k	3° 35′ 18″ S	114° 27′ 17″ E	x	3° 39′ 48″ S	114° 25′ 25″ E
l	3° 35′ 49″ S	114° 28′ 15″ E	y	3° 39′ 42″ S	114° 28′ 36″ E
m	3° 37′ 50″ S	114° 30′ 15″ E	z	3° 41′ 14″ S	114° 24′ 40″ E

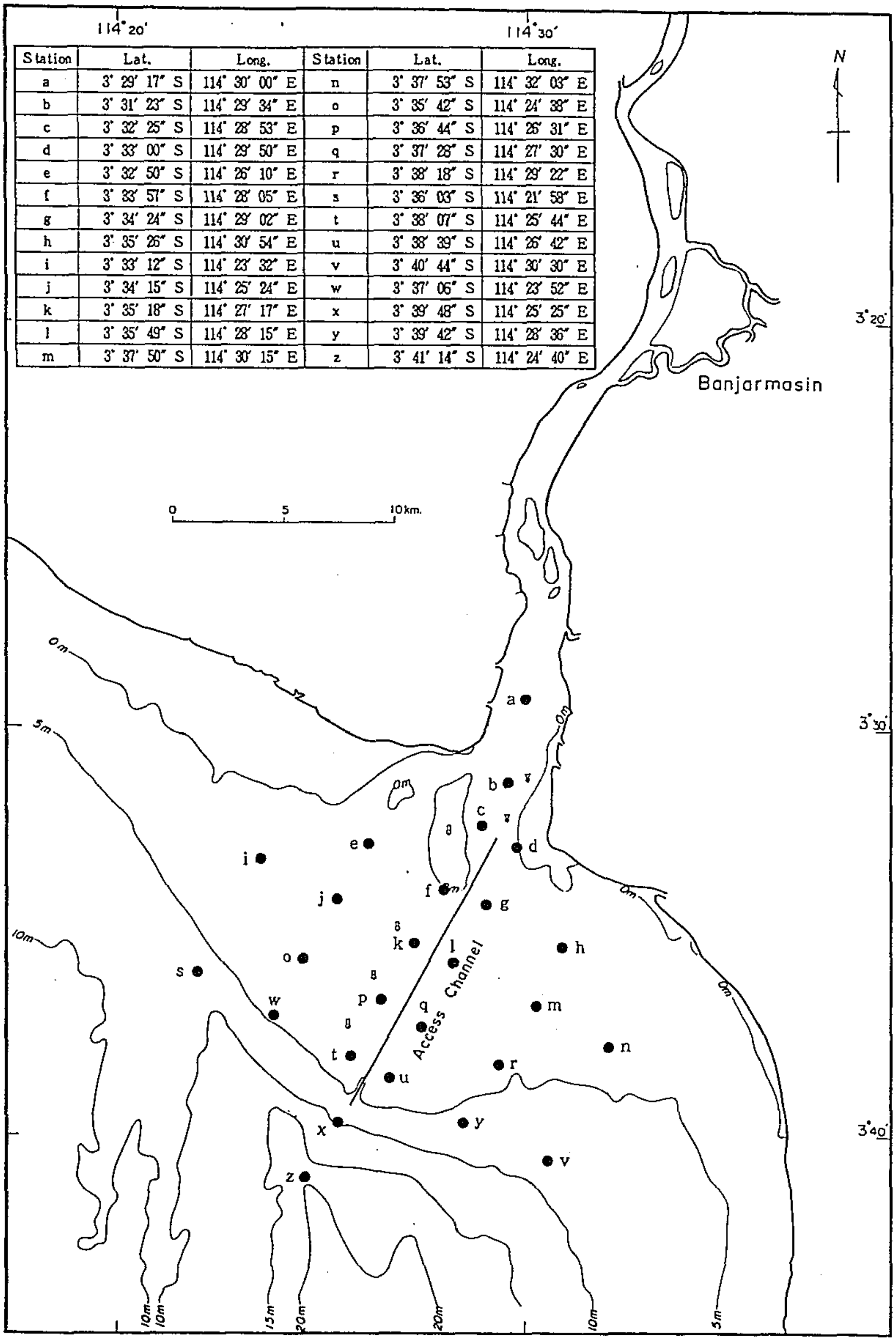


Fig. 4.3 −10 Bottom Material, Salinity and Suspended Soild Survey Points

4.4 Others

4.4.1 Echo-sounding in Wide Area

1)Method

Echo-sounding was carried out by an echo-sounder(Frequency: 210 kHz), as shown in Fig. 4.4-1.

Sounding line was set at an interval of 0.5Km, and the direction of lines was in N-S direction.
Tide corrections were made on the obtained depths using observational tide data.
Sound velocity corrections were made on obtained depth by the bar-check method.

2)Area

The sounding area(40 Km x 30 Km) was shown in Fig. 4.4-2.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.4-1.

4)Data Processing

Following Charts were made by results of Echo-sounding in Wide area.

- Tracking Charts	(Scale : 1/50000)
- Bathymetric Charts	(Scale : 1/50000)
- Contour Charts	(Scale : 1/50000)
- Longitudinal Section	(8 lines)
- Transverse Section	(10 lines)

Table 4.4-1 List of Equipment and Goods for Echo-sounding

Equipment Name	Type	Manufacturer	Number
Echo-sounding(210 KHz)			1
Check Bar	-	-	1
Accessories & Consumable	-	-	1

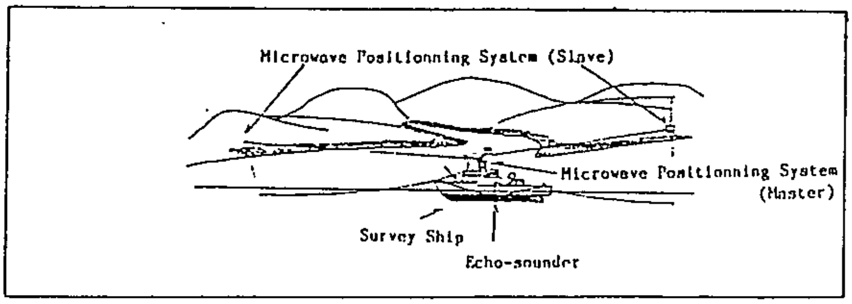
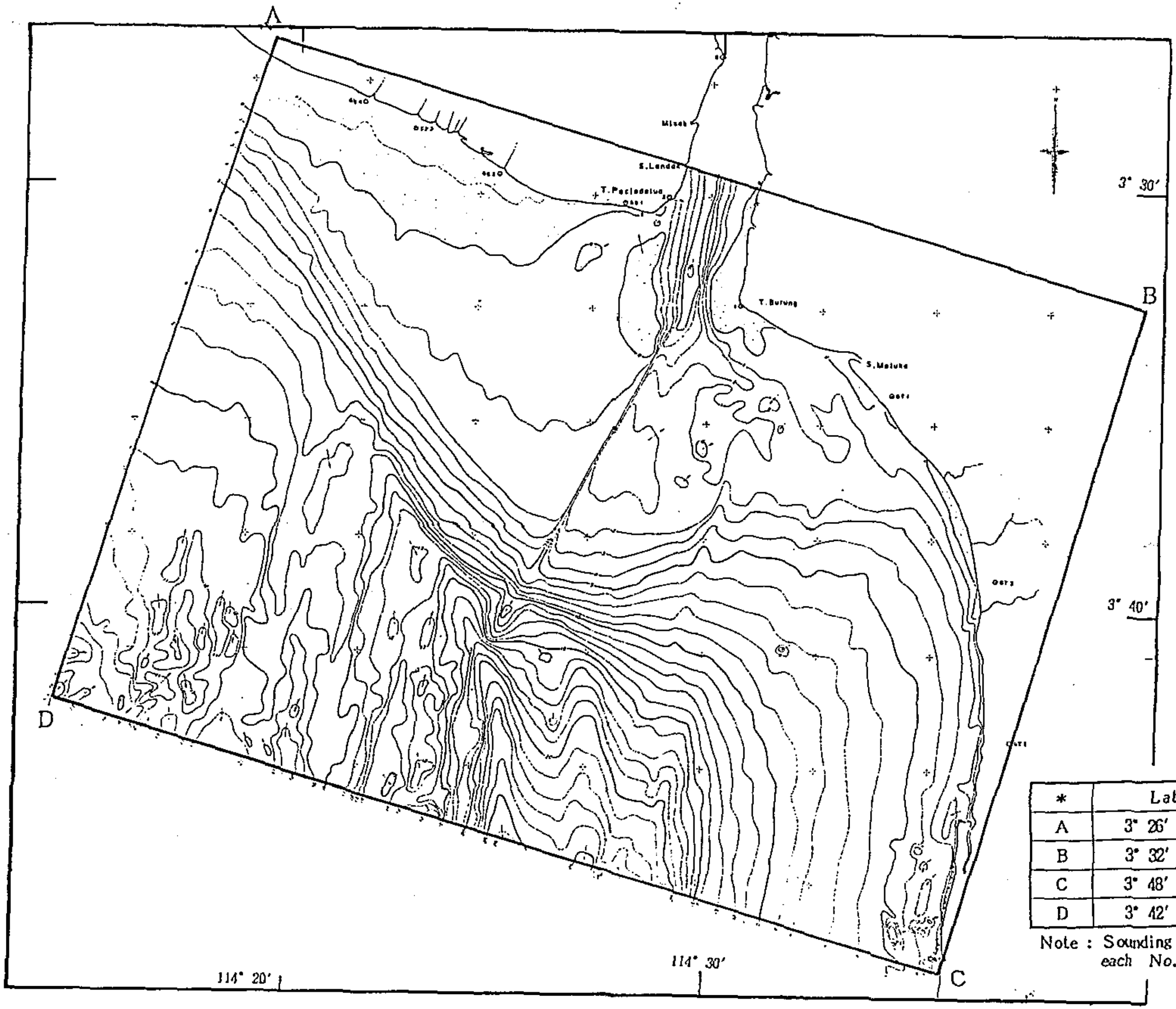


Fig. 4.4-1 Echo-sounding Method in Wide Area



*	Lat.	Long.
A	3° 26′ 27″ S	114° 19′ 30″ E
B	3° 32′ 47″ S	114° 40′ 11″ E
C	3° 48′ 25″ S	114° 35′ 34″ E
D	3° 42′ 02″ S	114° 14′ 50″ E

Note : Sounding area is connected by each No. of * with line.

Fig. 4.4－2 Echo-Sounding Area (Wide Area)

4.4.2 Soil Boring

1)Method

Soil borings were carried out at three(3) points using a drilling scaffold, as shown in Fig. 4.4-3.

The planned depth of soil boring was 20m below seabed.

A standard penetration test(N-value) and undisturbed soil sampling were carried out at an interval of 2.0m.
Pocket Vane Shear Tests were carried out about the upper undisturbed samples.

2)Position

The position of soil boring were shown in Fig. 4.4-4.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.4-2.

4)Data Processing

Samples taken by soil boring were analysed about following items.

- Vane Test
- Natural Water Content and Volumetric weight
- Specific Gravity
- Liquid Limit and Plastic Limit
- Grain Size Analysis
- Unconfined Compression Test

Table 4.4-2 List of Equipment and Goods for Soil Boring

Equipment Name	Type	Manufacturer
Boring Machine	YSO-1	Yoshida Boring Machine Manufacturing Co., LTD.

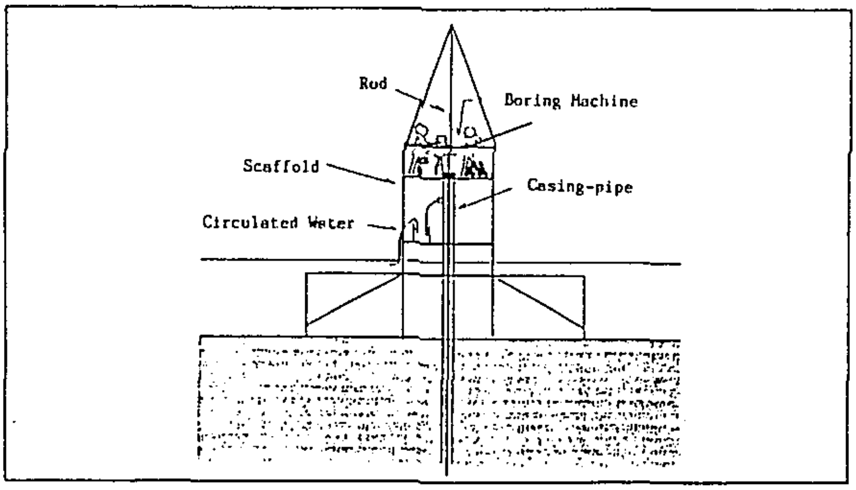
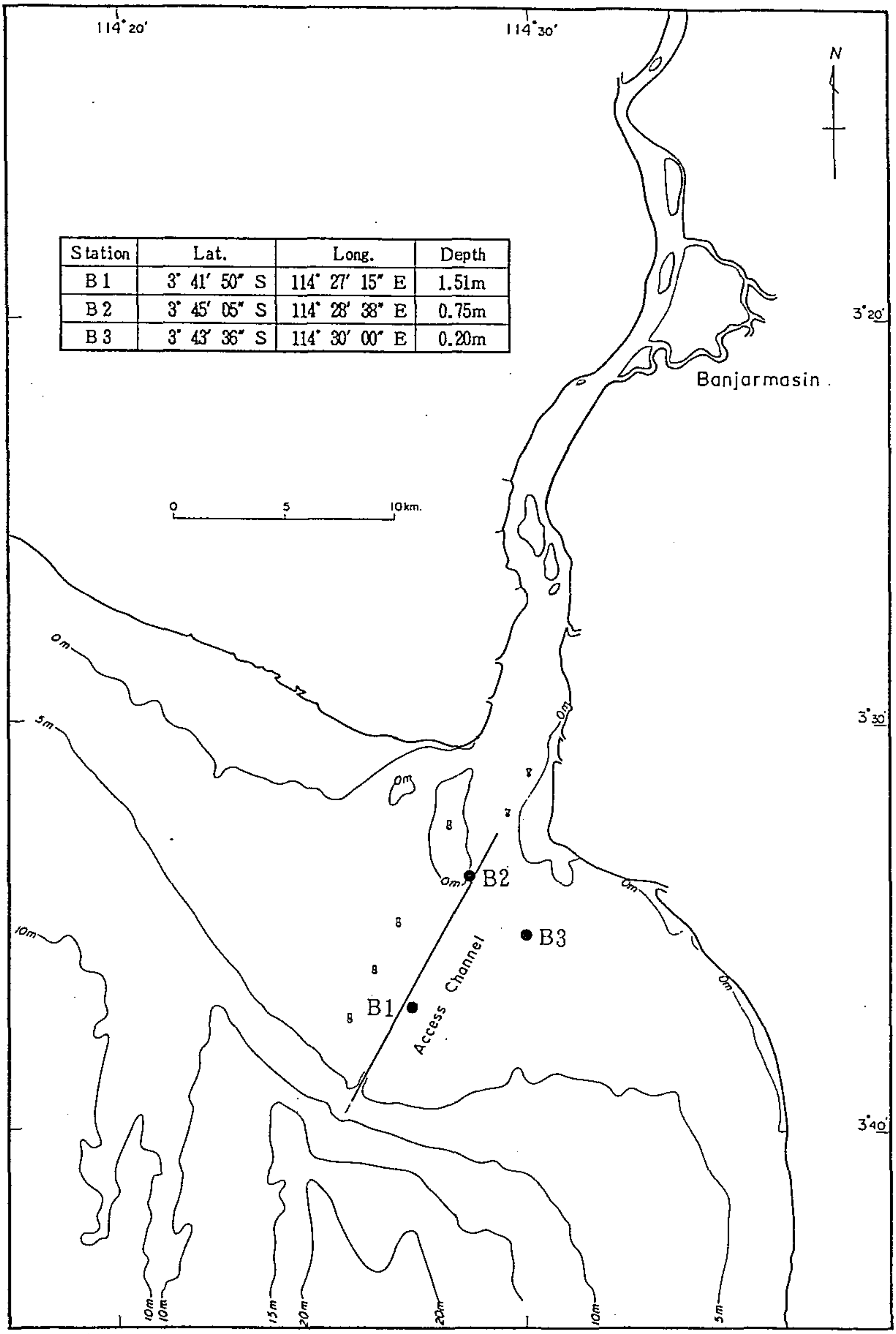


Fig. 4.4-3 Soil Boring Method



Station	Lat.	Long.	Depth
B1	3° 41′ 50″ S	114° 27′ 15″ E	1.51m
B2	3° 45′ 05″ S	114° 28′ 38″ E	0.75m
B3	3° 43′ 36″ S	114° 30′ 00″ E	0.20m

Fig. 4.4－4　Soil Boring Survey Points

4.4.3 Seabed Level

1)Method

It was a purpose of this survey that seabed level was confirmed by means of various methods as shown in Fig. 4.4-5.

The seabed level was measured by a lead line, a direct-reading type electromagnetic current meter(EMC-107), an echo-sounder with multi-frequency transducer(ATLAS DESO 10) and a bottom core sampler.

In case of measuring by a lead line, when a lead touched on the seabed, the touched location was indentified as a seabed.

In case of measuring by a electromagnetic current meter, the surface layer of a surmised fluid mud was identified at 0 m/sec of current velocity.

In case of measuring by an echo-sounder, a reflected surface which was sounded by 210kHz was indentified as a surface layer of a surmised fluid mud and a reflected surface which was sounded by 33kHz was indetified as a seabed.

A bottom core sampler was used for confirming a condition of sedimentation on the seabed. Then a core sampler was frozen and devided into 5 pcs for soil tests at 5 layers. These devided core samples were transported to laboratory and soil test was carried out about each sample.

2)Position

The positions of survey were shown in Fig. 4.4-6.

3)Equipment/Goods

Equipment and Goods were listed in table 4.4-3.

4)Data Processing

Following conditions were investigated by Seabed Level Survey.

- To compare with the condition of fluid mud by differ frequencies, survey were carried out by using multi-frequency echo-sounder with 210kHz and 33kHz. Submarine topography by echo-sounding and water depth by lead line were comprised.

- To examine the phisical environment adjacent to fluid mud layer , vertical disiribution of current direction and velocity, salinity and SS were observed by using an electromagnetic currentmeter.

- A core sample was divided into five pcs and natural water content and bulk unit weight were analysed for the purpose of examining differ layer.

Table 4.4-3 List of Equipment and Goods for Seabed Level

Equipment Name	Type	Manufacturer	Number
Electromagnetic Current Meter	EMC-107	Yokogawa	1
Echo-sounder with multi-frequency transducer	ATLAS DESO 10		1
Lead Line	2.7 Kg		1
Bottom Sampler	Core Type		1

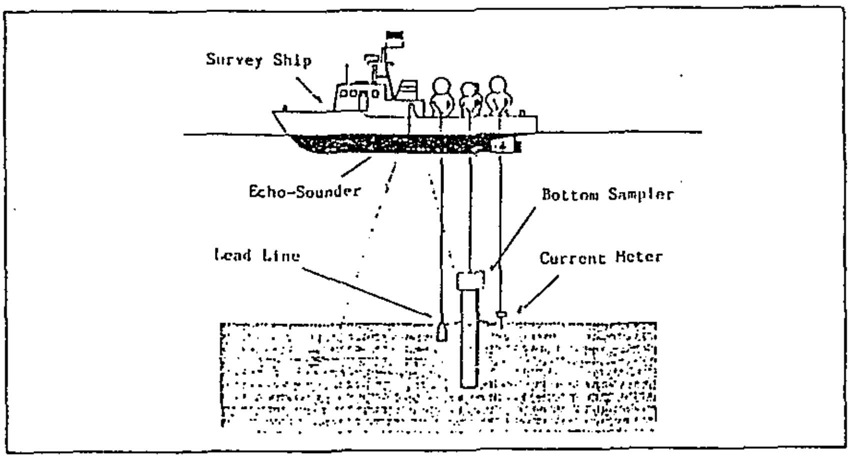


Fig. 4.4-5 Seabed Level Survey Method

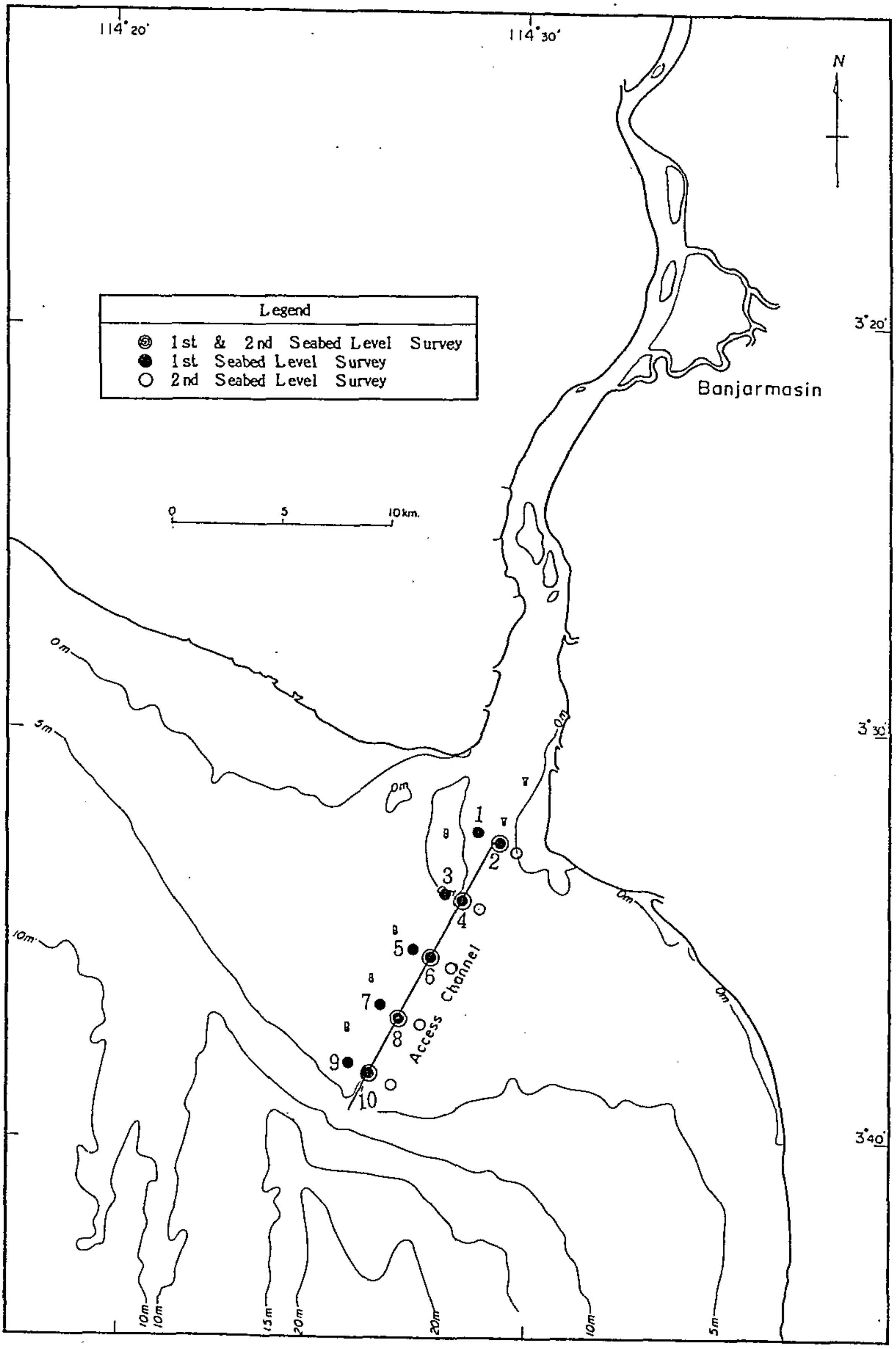


Fig. 4.4 − 6 Seabed Level Survey Points

4.4.4 Bottom Sampling

1)Method

Bottom sampling(400l) was conducted by using a grab sampler of the method as shown Fig. 4.4-7.

The volume of the bottom material was 400l.

The sample was transported to Japan and was for In-situ test at the Port and Harbor Research Institute, Ministry of Transport, Japan.

2)Position

The position of the bottom sampling was shown in Fig. 4.4-8.

3)Equipment/Goods

Equipment and Goods were listed in Table 4.4-4.

Table 4.4-4 List of Equipment and Goods for Bottom Sampling

Equipment Name	Type	Manufacturer	Number
Bottom Sampler	Grab Type		1
Drum Container for Bottom Material	200l		2

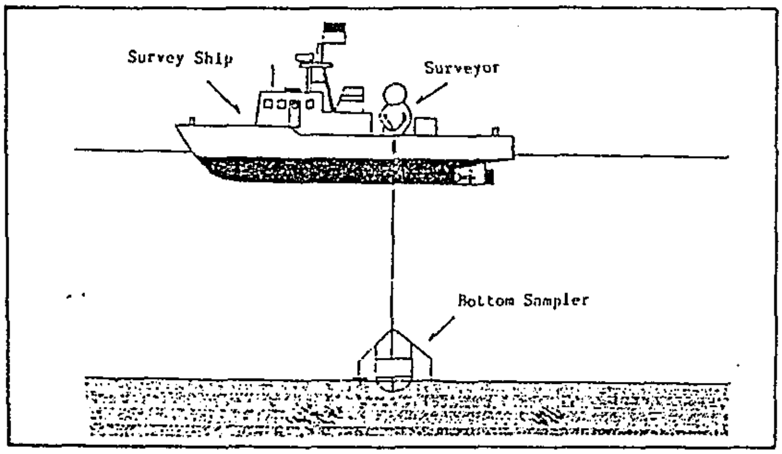


Fig. 4.4-7 Bottom Sampling Method

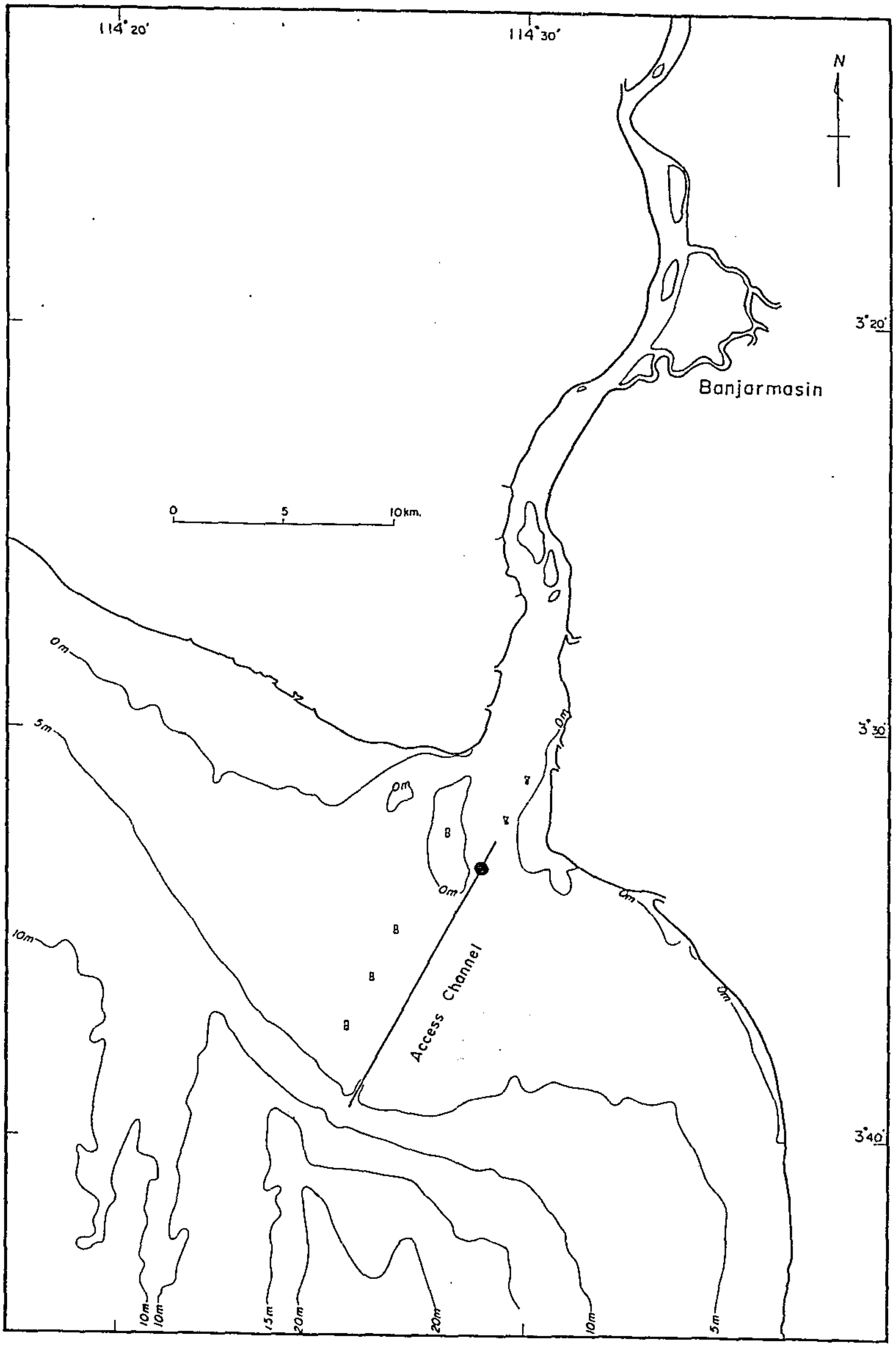


Fig. 4.4-8 Bottom Sampling Point

4.5 Existing Data

Since there were various existing data, such as tide, wind, and etc. which had been obtained by the past observation in Banjarmasin and the hinterlands. Therefore these data were collected by JICA Study Team under cooperation of the counterpart and the Indonesia agencies concerned.
And these data were used for the purpose of comparing with the results of the natural condition survey, analisys of the reapperance and examining for variation in long term.

The data concerned are shown as follows ;

(1)Existing image data by satellite

- -Topography(especially shore line)
- -Water temperature
- -S.S.
- -Diffusion of turbidity

(2)Past field data

- -Wind
- -Precipitation
- -Sounding
- -Topography

5. Results of Survey

5.1 Yearlong Survey

5.1.1 Tides

1) Tides

As for tidal levels, the records which had been observed at Pilot Station and water depth data which had been measured with wave height observation at St.1 where located in the offing end of the access Channel were comprised.
On the other hand, tidal level data at a tide observation station of Trisakti in Banjarmasin Port were collected.
Tidal curves in St.1, Pilot Station and Trisakti were made by using the aforementioned data.
Looking over the relation of locations among three tide observation stations, followings were found.

Linear distance from St.1 to Pilot Station is about 17km and vast shallow sea area exists there between two points.
Distance from Pilot Station to Trisakti is about 20km away and the Barito river and swamp extends there between both stations.
Thus distances among three station are far away each other.
Therefore relation of datum levels among three stations were not connected.

Observational durations at each station are as follows;

- Pilot Station : 1st Sep. 1988 - 1st Sep. 1989
  (Observational data: Read data every 1 hour)
- St.1(Wave height survey station)
  :10th Sep.1988 - 10th Sep. 1989
  (Observational data: Recorded data every 2 hours)
- Trisakti : 6th Feb. 1989 - 30th Aug. 1989
  (Observational data: Read data every 1 hour)

A typical example of tidal curve in June 1989 was shown in Fig.5.1.1-1.
According to tidal curve at Trisakti, some attentions must pay to the tidal appearance at Trisakti because it seemed that variation of water level near low water not followed to descending tidal level.

Tides in the survey sea area shows distinctly diurnal tide and the range of tide becomes maximum at around time when declination of the lunar becomes maximum in south or north (the lunar reaches the tropic of Capricorn(S) or Cancer(N)).

And the range of tide becomes minimum at around time when the lunar locates near the equator. Thus variation of the range of tides are shown periodically.

Examining the ranges among three stations, St.1 in the offing was comperatively large and Trisakti upstream area of the Barito river was rather small and the ranges among three stations showed some discrepancies.

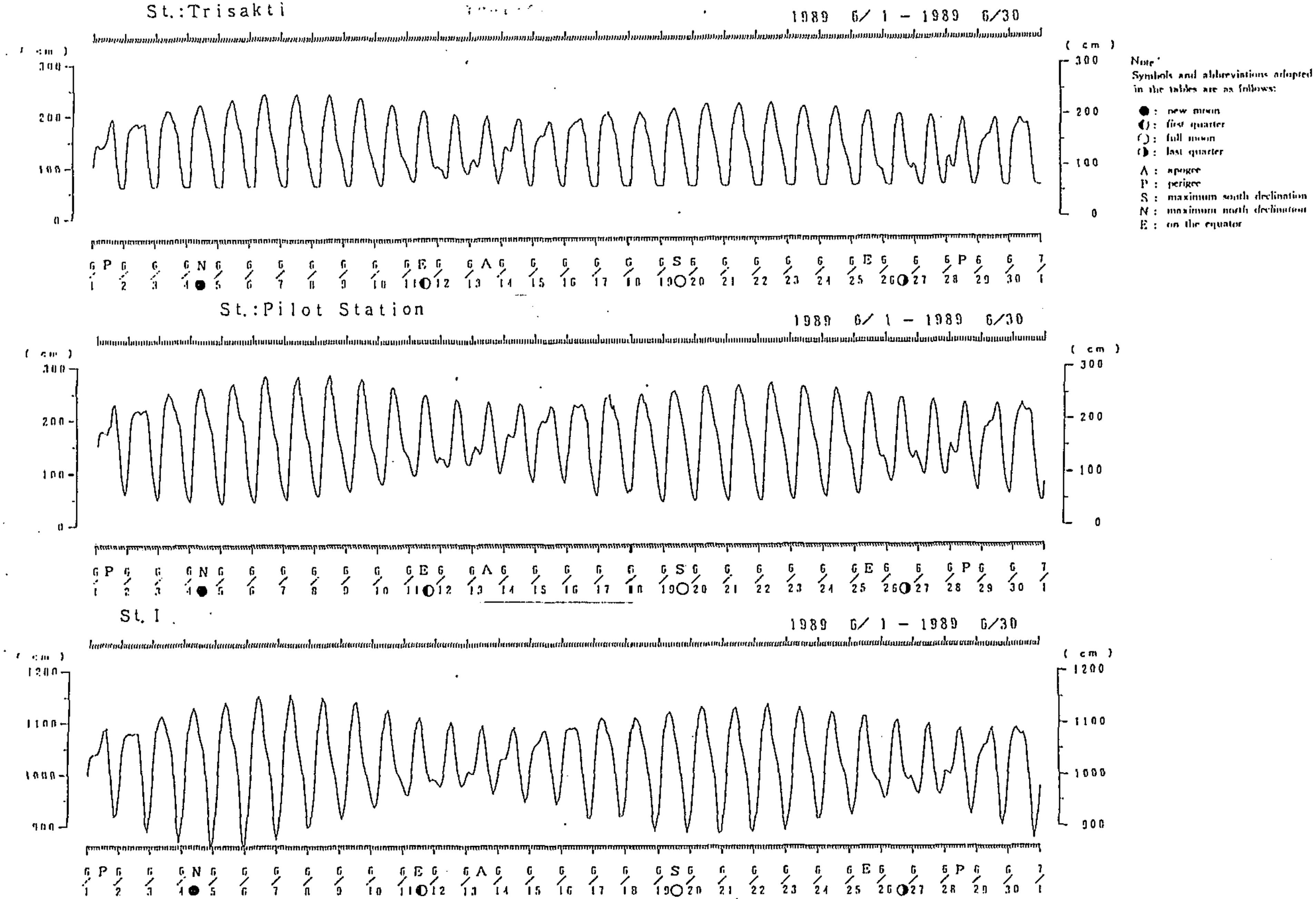


Fig. 5. 1. 1-1 Tidal Curves

2) Tidal harmonic analysis

Results of the tidal harmonic analysis at Pilot Station and wave height survey station(St.1) were made by using data for a year with a method of the least square. The results are shown in Table 5.1.1-1.

Generally speaking, tides are classified in three types, such as semi-diurnal, diurnal and mixed types.
These types are obtained by tidal harmonic analysis as follows ;

Semi-diurnal type : $\frac{K1+O1}{M2+S2} < 0.25$

Mixed type : $0.25 < \frac{K1+O1}{M2+S2} < 1.25$

Diurnal type : $1.25 < \frac{K1+O1}{M2+S2}$

The types of tide at Pilot Staion and St.1 were obtained by the this method.

Pilot Station : $\frac{K1+O1}{M2+S2} = \frac{(59.47+29.54)cm}{(31.74+0.24)cm} = 2.62$

St.1 : $\frac{K1+O1}{M2+S2} = \frac{(63.34+33.21)cm}{(31.77+4.03)cm} = 2.70$

These results show that types of tide at Pilot Station and St.1 belongs diurnal tide type.

Principal four tidal constants between Pilot Satation and Trisakti were summarized as under for the purpose of comparison.

Results of Harmonic Analysis for Principal 4 Tidal Constants

Tidal Constants	Pilot Station				St.1			
	K1	O1	M2	S2	K1	O1	M2	S2
Amplitude(cm)	59	30	32	2	63	33	32	4
Phase(deg.)	337	287	159	69	331	282	139	63

Tidal Constants	Trisakti			
	K1	O1	M2	S2
Amplitude(cm)	50	25	26	4
Phase(deg.)	339	280	157	343

Time : G.M.T. +8:00
(Source of Trisakti : Final Report of Technical Survey for Port of Banjarmasin, Dec. 1984)

Examinig principal four tidal components, K1 component in diurnal tide and M2 component in semi-diurnal tide are dominant.
So amplitudes of K1 component at each station were compared and found following results.
The maximum amplitude with 63cm showed at St.1 and next was at Pilot Station with 59cm and minimum amplitude was 50cm at Trisakti.
It was found that the father distance extended to the river from sea, the more amplitude decreased.
It is considered that amplitude of K1 which entered to the river through the shallow sea area decreased by increasing friction resistance with seabed during tides propagated upstream of the river.
Amplitudes in M2 component also decreased in order at St.1 and Pilot station with 32cm and at Trisakti with 26cm.
That is also able to be explained by the aforementined reason.

Table. 5.1.1－1 Results of Tidal Harmonic Analysis

PILOT STATION

Analysis Duration :
1 Sep. 1988～31 Aug. 1989

NO	NAME	AMPLITUDE	PHASE
1	CONST	1.627	
2	SA	0.0920	304.6924
3	SSA	0.0645	157.0332
4	MM	0.0106	35.4127
5	MSF	0.0114	348.1692
6	MF	0.0033	37.5225
7	S1	0.0182	82.7589
8	K1	0.5947	337.1472
9	P1	0.1725	333.7290
10	M1	0.0194	325.3479
11	J1	0.0253	54.3434
12	O1	0.2954	287.2568
13	OO	0.0374	33.9379
14	RHO1	0.0112	263.0535
15	Q1	0.0442	272.6418
16	2Q	0.0145	241.2870
17	S2	0.0240	69.0925
18	T2	0.0025	203.5530
19	R2	0.0048	210.0373
20	K2	0.0413	99.5085
21	L2	0.0315	218.4569
22	LAM2	0.0083	215.2452
23	M2	0.3174	158.5551
24	2SM	0.0093	214.4729
25	N2	0.0804	127.0694
26	NYU2	0.0214	142.3382
27	MYU2	0.0112	321.3391
28	2N	0.0166	52.0033
29	MK	0.0258	44.1445
30	M3	0.0069	240.7189
31	S4	0.0019	92.6374
32	MS	0.0050	270.8748
33	M4	0.0361	236.3324
34	MN	0.0160	195.5384
35	M6	0.0021	292.8176

St.1

Analysis Duration :
10 Sep. 1988～10 Sep. 1989

NO	NAME	AMPLITUDE	PHASE
1	CONST	10.241	
2	SA	0.1331	317.3672
3	SSA	0.0612	173.8066
4	MM	0.0055	317.9810
5	MSF	0.0022	274.8132
6	MF	0.0167	29.4983
7	S1	0.0053	174.5669
8	K1	0.6333	330.6877
9	P1	0.1808	328.2627
10	M1	0.0213	314.7173
11	J1	0.0387	38.6008
12	O1	0.3321	281.8726
13	OO	0.0312	29.8383
14	RHO1	0.0128	266.3669
15	Q1	0.0568	267.9690
16	2Q	0.0100	194.8235
17	S2	0.0403	62.5306
18	T2	0.0052	181.7036
19	R2	0.0015	113.0171
20	K2	0.0231	61.0296
21	L2	0.0101	213.7120
22	LAM2	0.0093	191.8078
23	M2	0.3177	138.7188
24	2SM	0.0077	179.1956
25	N2	0.0865	107.3213
26	NYU2	0.0219	122.8658
27	MYU2	0.0092	278.3577
28	2N	0.0134	313.0522
29	MK	0.0077	291.3977
30	M3	0.0154	264.5483
31	S4	0.0028	26.4934
32	MS	0.0093	327.2078
33	M4	0.0124	240.2371
34	MN	0.0045	214.3420
35	M6	0.0014	348.9700

Unit : m

3) Monthly mean tidal level

Monthly mean tidal levels at three stations are shown in Fig.5.1.1-2 for examining the variation of tidal level.

Monthly mean tidal level in the survey sea area shows high tendency in rainy dry season and it seems to be corresponded to the variation of water level in the Barito river.
Maximum tidal levels at Pilot Station and St.1 in the year appeared in December 1988 with 179cm and 1041cm,respectively.
Minimum tidal levels were 149cm and 1004cm, respectively,in September 1988.
Differ between maximum and minimum at each station were 30cm at Pilot Station and 37cm at St.1, respectively.
It of Pilot Station was rather small comparing with St.1.

Table. 5.1.1－2 Monthly Mean Water Level

Unit: cm

month year	Pilot Station	Trisakti	St.1
Sep. 1988	149	－	1004
Oct. 1988	156	－	1012
Nov. 1988	174	－	1033
Dec. 1988	179	－	1041
Jan. 1989	167	－	1034
Feb. 1989	167	139	1033
Mar. 1989	167	144	1034
Apl. 1989	163	140	1027
May 1989	160	136	1019
Jun. 1989	163	137	1023
Jul. 1989	159	132	1018
Aug. 1989	151	124	1010

Note: DL at each station.
(Relation of Water depth between three Stations are unknown.)

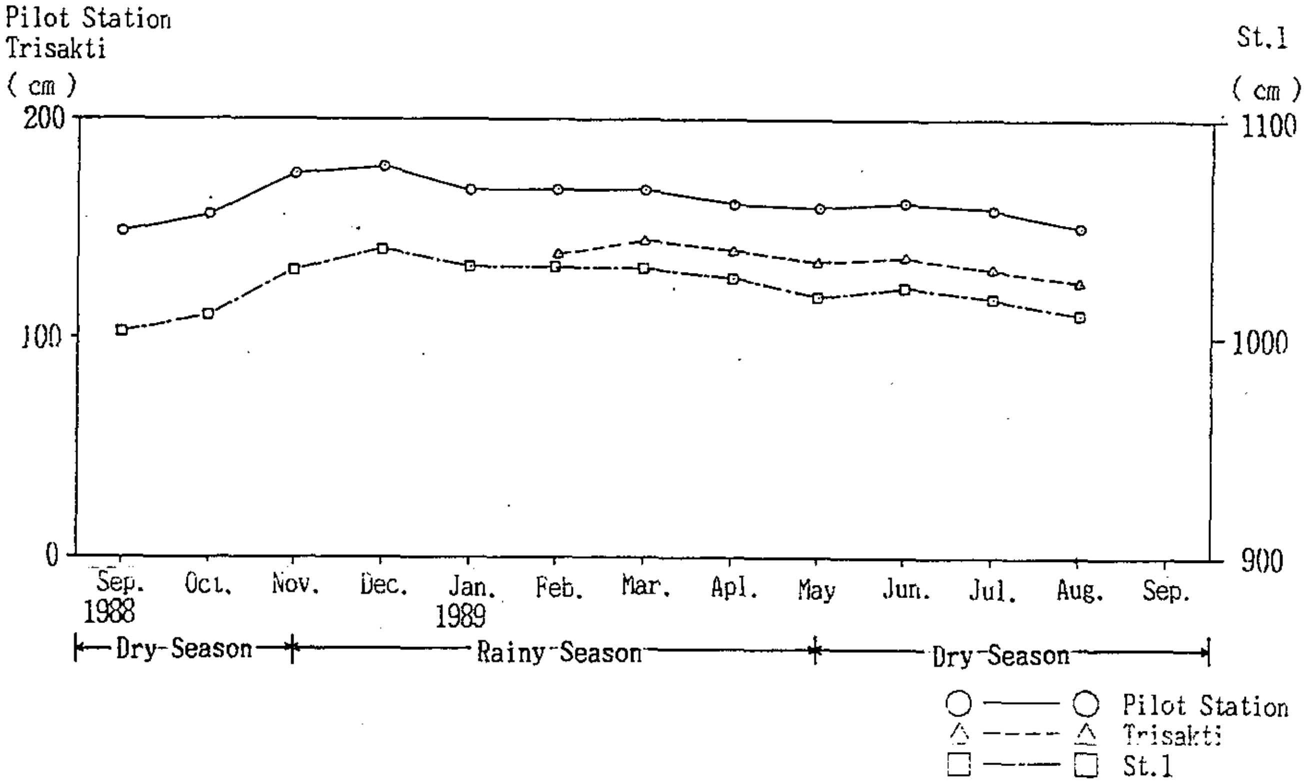


Fig. 5.1.1－2 Variation of Monthly Mean Water level

4) Amplitude

Fig. 5.1.1-3 was made by the differences between water levels at High water and Low water in company of one tidal period.

Range of amplitude at Pilot Station was between max. 235cm and min. 75cm. Range of it at Trisakti was between max. 192cm and min. 72cm. Comparing with both stations, amplitude at Pilot Staion was lager than it of Trisakti.

Examining the variations in the amplitudes at both stations, it seems to be varied with a period of 15 days and their peaks correspond to the locating time of the lunar in maximum declination. On the other hand, amplitudes become minimum at the time of lunar on the equator.

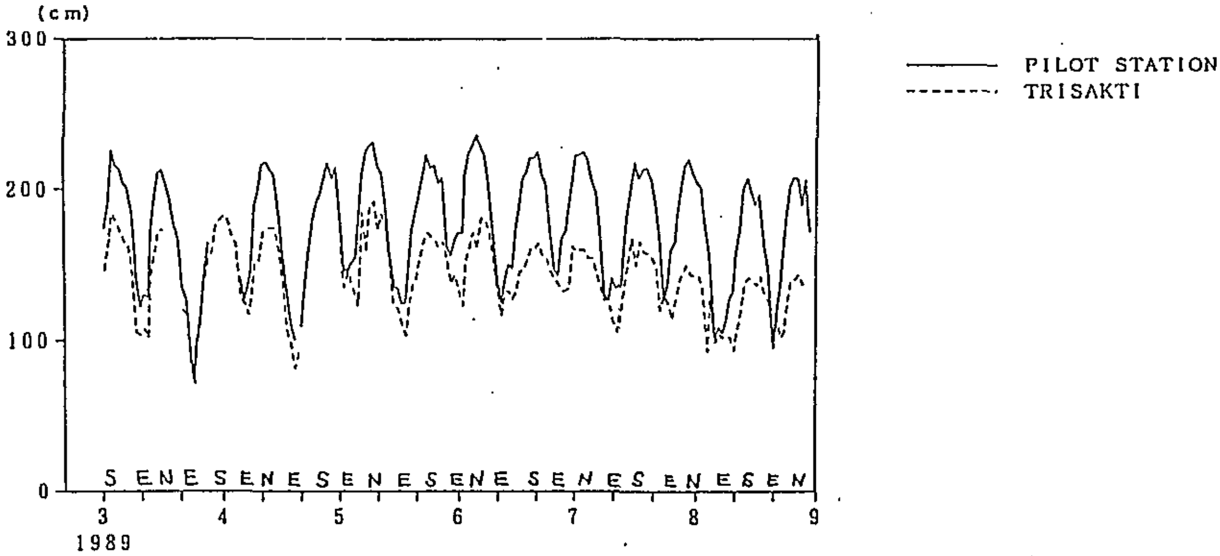


Fig. 5.1.1－3 Amplitude (difference of Tidal Level) in Time Series

5) Relation map of Tide Level

Datum level for tide observation at Pilot Staion was determined by the level survey basing upon a bench mark (L.W.S : 3.346m) which was established on the basement beneath the iron tower beside the Pilot Staion's house.

The maximum tide level through the all survey terms was 3.23m above L.W.S and the minimum tide level is 0.34m. Sum of principal four tidal constants(Z0) was 1.627m. Fig. 5.1.1-4 was made as a relation map of tidal level for the tidal observational station by using the above figures of the elements.

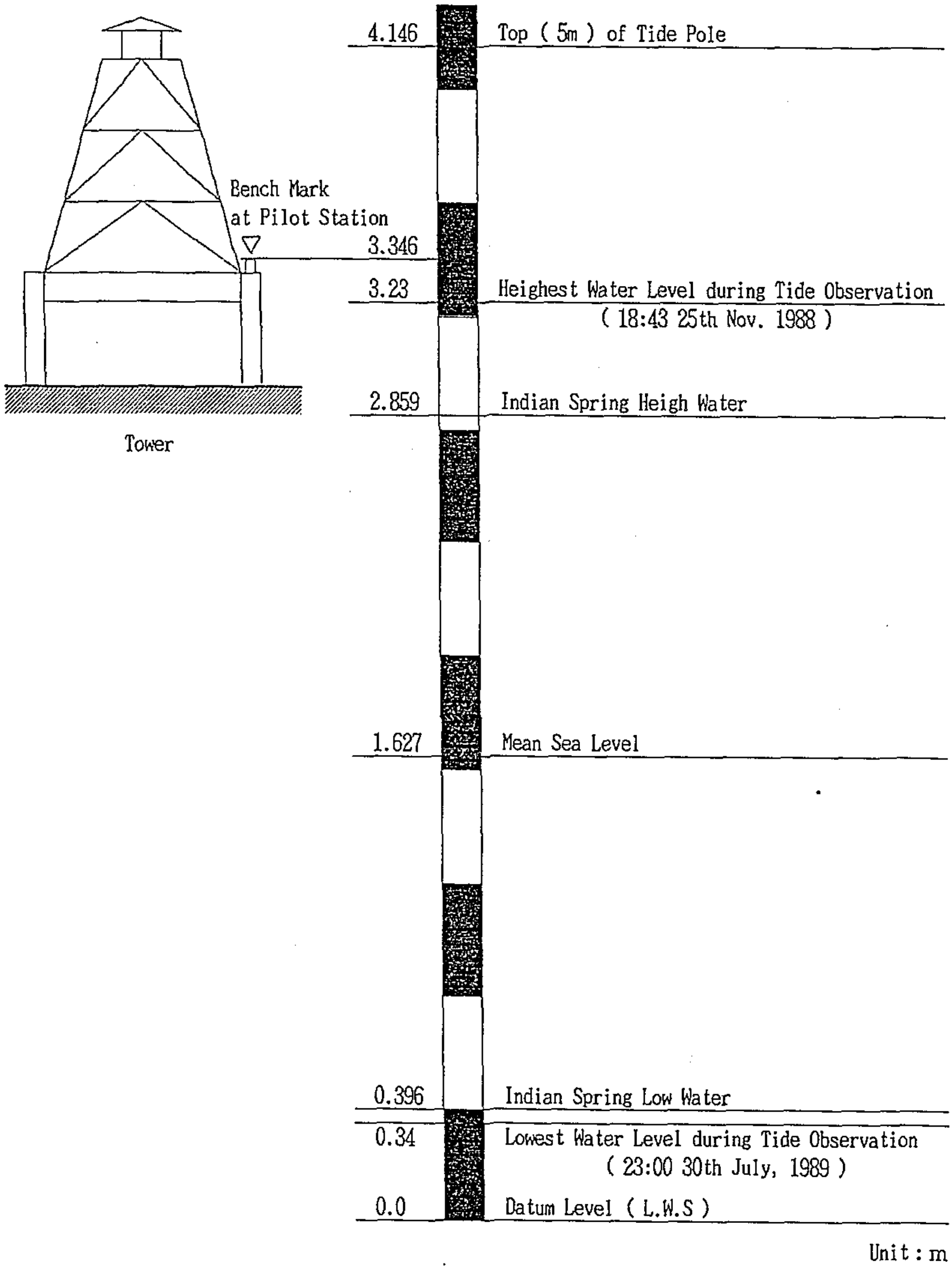


Fig. 5.1.1 − 4 Relation of Tide Level at Pilot Station

5.1.2 Wind

Wind observation was carried out 1st September 1988 to 1st September 1989.

According to the observed wind data, tendencies of wind in the dry and rainy season are slightly differ. Therefore, wind data are classified in the following periods and the frequencies are obtained.

-All seasons : 1st Sep. 1988- 1st Sep. 1989
(Refer to Fig. 5.1.2-1)

-Rainy season : 1st Nov. 1988-30th Apr. 1989
(Refer to Fig. 5.1.2-2)

-Dry season :Two durations in the dry seasons combined with 1st Sep.-31st Oct. 1988 and 1st May-31st Aug.1989. Each one duration in separation of the both terms.
(Refer to Fig. 5.1.2-3)

Examining the frequency distribution of wind through all seasons as shown in Fig.5.1.2-1, the frequencies of wind direction are able to be generally separated into three principal directions as dominant wind directions such as 27% in SE-S, 25% in N-NE and 19% in SSW-WSW through a year.

Examinig frequencies of wind velocity every rank,the frequency of velocity less than 5m/s was 95%. Further examination carried out about velocity in this rank in details and found that velocity rank of 2-3m/s occupied 44%.
Thus wind velocity was a little tendency in the whole.
Frequency of strong wind velocity more than 5m/s was 5% and maximum velocity was 9.9m/s (Occured on 29th Jan.1989).

Frequency distribution of wind in rainy season was shown in Fig.5.1.2-2.

Examining this figure, principal wind directions in frequency were 28% in SW-W and 28% in N-NE and separated into two groups such as WSW'ly group and Nothern group as principal directions.

Examing relation between wind velocities and directions, in case of wind direction Nothern group blew from shore, velocity was less than 5m/s and weak wind.
However, in case of wind direction blew in rainy(momsoon), 2% of velocity 5-9m/s in rank appeared. Compared with velocity between WSW'ly group and Nothern group, frequency of strong wind velocity rank in the former appeared higher than the later.

Frequency distribution of wind in dry season was shown in Fig.5.1.2-3.

According to the figure, frequencies of principal three directions were 42% in SE-S and 23% in N-NE. Thus SSE'ly group was dominant.

Examining relation between wind velocities and directions, in case of Nothern group, wind velocity was less than 5m/s and weak as well as rainy season.
In case of SSE'ly group(monsoon in dry season), high frequency of wind velocity 5-7m/s in rank appeared.

SSE'ly wind dominated in the dry season and regularly blew from around 10 o'clock to 15 o'clock. This wind were a typical type of the land and sea breeze blew continuously, wind force was comparatively strong and exceeded velocity 6m/s.

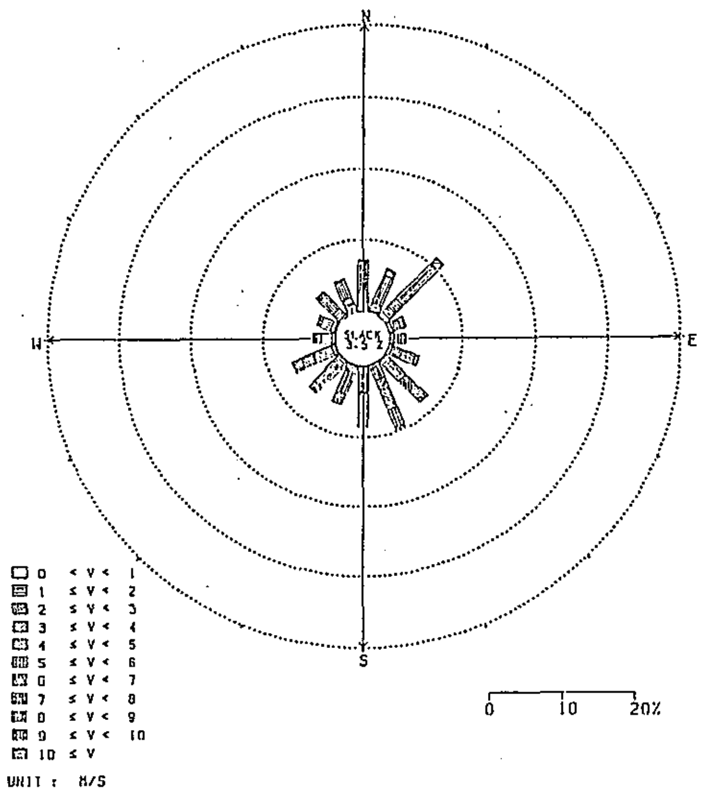


Fig. 5.1.2 − 1 Wind Rose for Yearlong

Table. 5.1.2 − 1
Frequency Distribution of Wind Direction and Velocity

Position : Pilot Station
Period : 1 Sep. 1988~ 1 Sep. 1989

Dir \ m/sec	0-	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	Total
-	307											307
	3.5											3.5
N	51	203	362	20	2	0	0	0	0	0	0	638
	0.6	2.3	4.1	0.2	0.0	-	-	-	-	-	-	7.3
NNE	26	85	375	81	10	0	0	0	0	0	0	577
	0.3	1.0	4.3	0.9	0.1	-	-	-	-	-	-	6.6
NE	72	220	595	99	5	2	0	0	0	0	0	993
	0.8	2.5	6.8	1.1	0.1	0.0	-	-	-	-	-	11.3
ENE	43	99	78	0	1	0	0	0	0	0	0	221
	0.5	1.1	0.9	-	0.0	-	-	-	-	-	-	2.5
E	42	94	59	2	1	0	0	1	0	0	0	199
	0.5	1.1	0.7	0.0	0.0	-	-	0.0	-	-	-	2.3
ESE	40	133	174	42	13	0	0	1	0	0	0	403
	0.5	1.5	2.0	0.5	0.1	-	-	0.0	-	-	-	4.6
SE	23	81	233	175	160	37	12	0	0	1	0	722
	0.3	0.9	2.7	2.0	1.8	0.4	0.1	-	-	0.0	-	8.2
SSE	18	28	146	142	262	211	58	0	0	0	0	865
	0.2	0.3	1.7	1.6	3.0	2.4	0.7	-	-	-	-	9.9
S	15	76	237	181	173	41	31	1	0	0	0	755
	0.2	0.9	2.7	2.1	2.0	0.5	0.4	0.0	-	-	-	8.6
SSW	20	71	294	90	38	11	4	0	0	0	0	528
	0.2	0.8	3.4	1.0	0.4	0.1	0.0	-	-	-	-	6.0
SW	23	94	335	65	30	7	1	0	0	0	0	555
	0.3	1.1	3.8	0.7	0.3	0.1	0.0	-	-	-	-	6.3
WSW	14	50	244	147	101	17	9	4	1	1	0	588
	0.2	0.6	2.8	1.7	1.2	0.2	0.1	0.0	0.0	0.0	-	6.7
W	14	36	130	54	28	9	3	2	0	1	0	277
	0.2	0.4	1.5	0.6	0.3	0.1	0.0	0.0	-	0.0	-	3.2
WNW	23	52	137	31	14	2	4	1	0	0	0	264
	0.3	0.6	1.6	0.4	0.2	0.0	0.0	0.0	-	-	-	3.0
NW	30	101	242	37	8	1	1	0	0	0	0	420
	0.3	1.2	2.8	0.4	0.1	0.0	0.0	-	-	-	-	4.8
NNW	34	153	237	19	3	0	0	0	0	0	0	446
	0.4	1.7	2.7	0.2	0.0	-	-	-	-	-	-	5.1
	795	1576	3878	1185	849	338	123	10	1	3	0	8758
	9.1	18.0	44.3	13.5	9.7	3.9	1.4	0.1	0.0	0.0	-	100.0

Short data : 2
Data obtained : 100.0 %

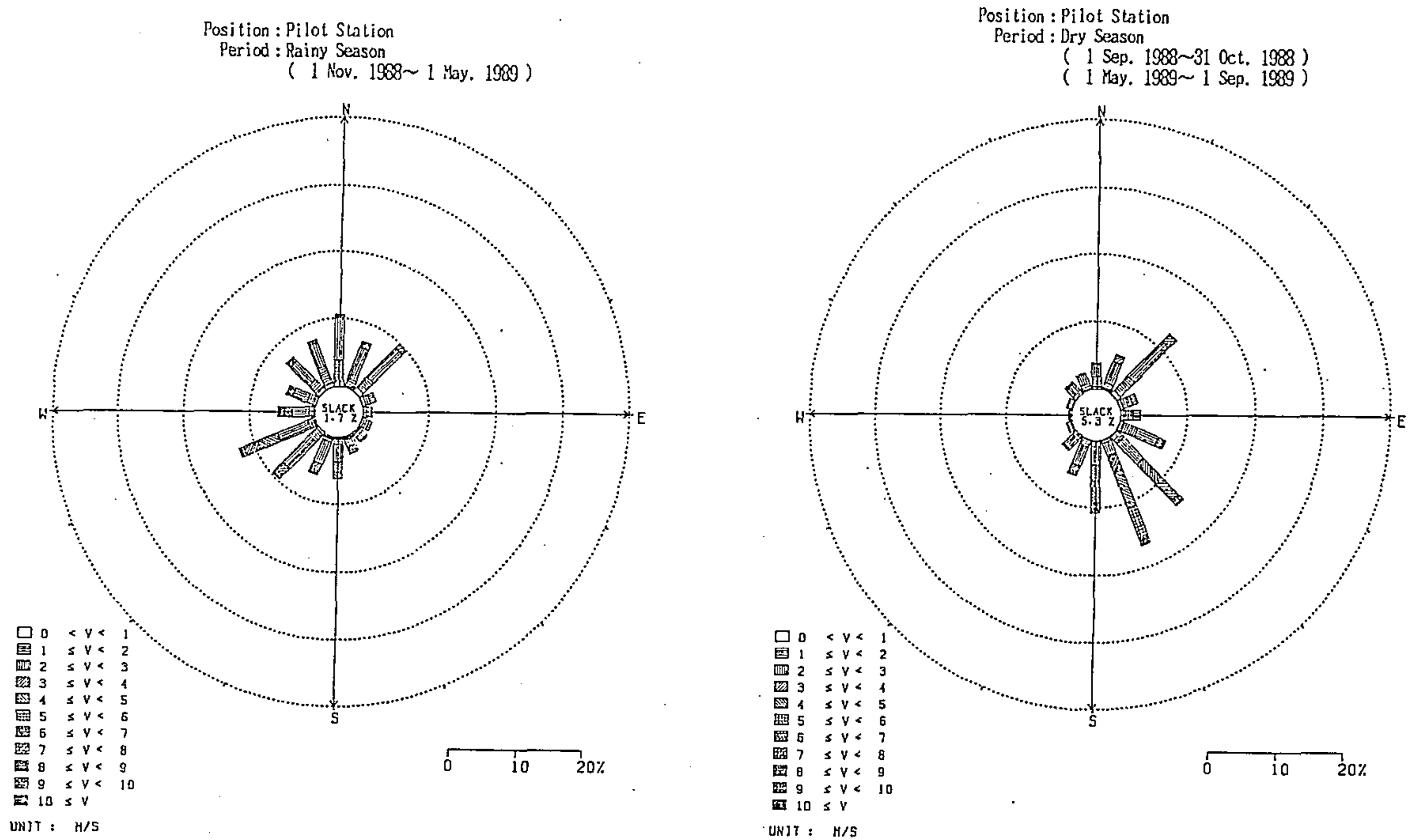


Fig. 5.1.2 − 2 Wind Rose for Rainy Season and Dry Season

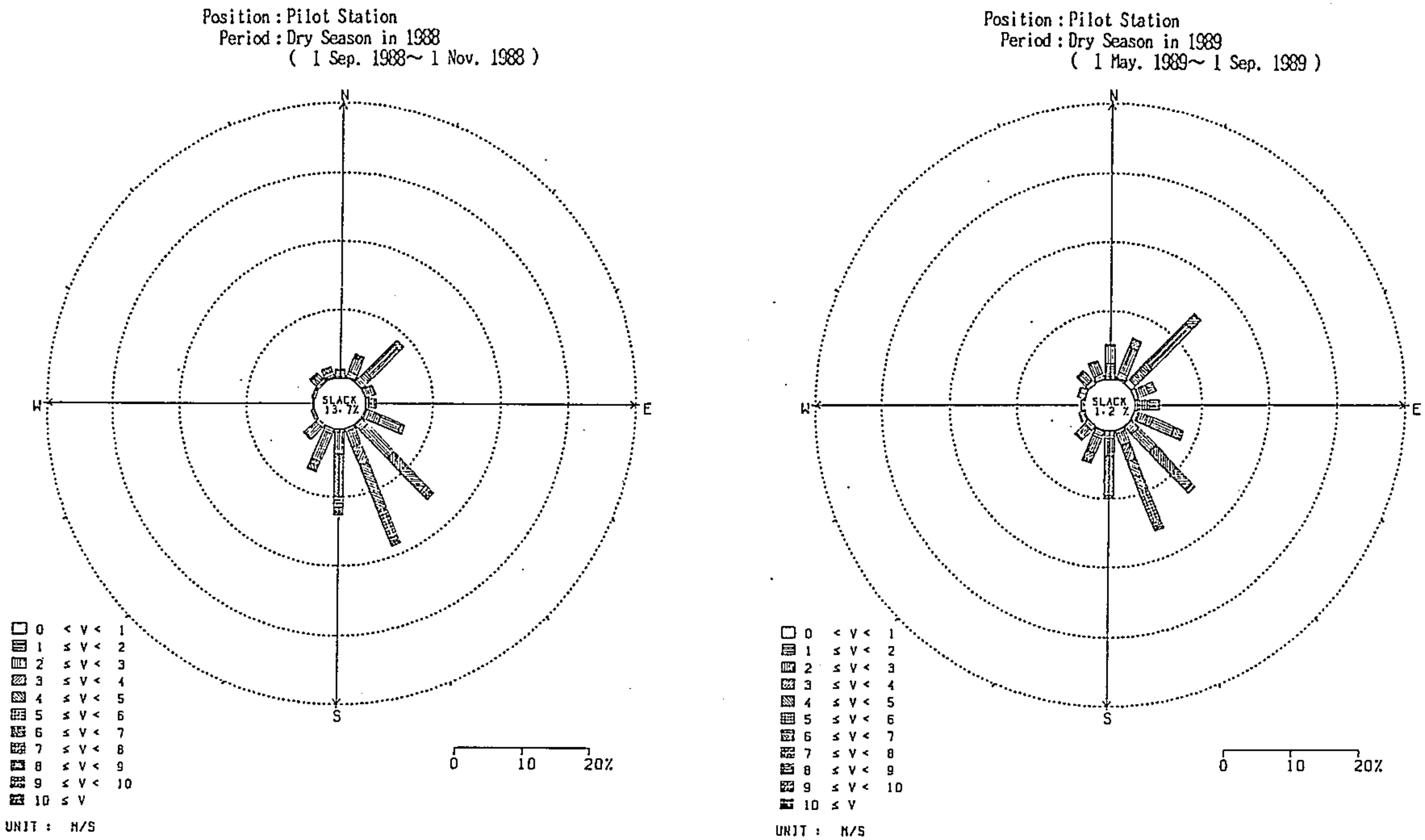


Fig. 5.1.2－3 Wind Rose for Dry Season

Table. 5.1.2 − 2
Frequency Distribution of Wind Direction and Velocity

Position : Pilot Station
Period : Rainy Season (1 Nov. 1988～ 1 May. 1989)

Dir \ m/sec	0-	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	Total
-	72											72
	1.7											1.7
N	35	136	278	13	1	0	0	0	0	0	0	463
	0.8	3.1	6.4	0.3	0.0	-	-	-	-	-	-	10.7
NNE	15	45	222	35	5	0	0	0	0	0	0	322
	0.3	1.0	5.1	0.8	0.1	-	-	-	-	-	-	7.4
NE	38	92	267	34	1	0	0	0	0	0	0	432
	0.9	2.1	6.1	0.8	0.0	-	-	-	-	-	-	9.9
ENE	23	33	39	0	0	0	0	0	0	0	0	95
	0.5	0.8	0.9	-	-	-	-	-	-	-	-	2.2
E	23	31	11	0	0	0	0	0	0	0	0	65
	0.5	0.7	0.3	-	-	-	-	-	-	-	-	1.5
ESE	18	30	22	0	1	0	0	0	0	0	0	71
	0.4	0.7	0.5	-	0.0	-	-	-	-	-	-	1.6
SE	14	22	39	5	6	0	0	0	0	1	0	87
	0.3	0.5	0.9	0.1	0.1	-	-	-	-	0.0	-	2.0
SSE	13	10	51	26	17	5	0	0	0	0	0	122
	0.3	0.2	1.2	0.6	0.4	0.1	-	-	-	-	-	2.8
S	9	39	115	69	38	5	0	1	0	0	0	276
	0.2	0.9	2.6	1.6	0.9	0.1	-	0.0	-	-	-	6.4
SSW	13	26	157	50	18	5	3	0	0	0	0	272
	0.3	0.6	3.6	1.2	0.4	0.1	0.1	-	-	-	-	6.3
SW	20	63	247	61	26	5	1	0	0	0	0	423
	0.5	1.5	5.7	1.4	0.6	0.1	0.0	-	-	-	-	9.7
WSW	11	40	219	143	99	17	9	4	1	1	0	544
	0.3	0.9	5.0	3.3	2.3	0.4	0.2	0.1	0.0	0.0	-	12.5
W	11	27	118	50	28	9	3	2	0	1	0	249
	0.3	0.6	2.7	1.2	0.6	0.2	0.1	0.0	-	0.0	-	5.7
WNW	19	43	106	29	13	2	2	0	0	0	0	214
	0.4	1.0	2.4	0.7	0.3	0.0	0.0	-	-	-	-	4.9
NW	27	72	176	26	5	1	1	0	0	0	0	308
	0.6	1.7	4.1	0.6	0.1	0.0	0.0	-	-	-	-	7.1
NNW	28	115	165	16	3	0	0	0	0	0	0	327
	0.6	2.6	3.8	0.4	0.1	-	-	-	-	-	-	7.5
Total	389	824	2232	557	261	49	19	7	1	3	0	4342
	9.0	19.0	51.4	12.8	6.0	1.1	0.4	0.2	0.0	0.1	-	100.0

Short data : 2
Data obtained : 100.0 %

Table. 5.1.2 − 3
Frequency Distribution of Wind Direction and Velocity

Position : Pilot Station
Period : Dry Season (1 Sep. 1988～31 Oct. 1988)
(1 May. 1989～ 1 Sep. 1989)

Dir \ m/sec	0-	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	Total
-	235											235
	5.3											5.3
N	16	67	84	7	1	0	0	0	0	0	0	175
	0.4	1.5	1.9	0.2	0.0	-	-	-	-	-	-	4.0
NNE	11	40	153	46	5	0	0	0	0	0	0	255
	0.2	0.9	3.5	1.0	0.1	-	-	-	-	-	-	5.8
NE	34	128	328	65	4	2	0	0	0	0	0	561
	0.8	2.9	7.4	1.5	0.1	0.0	-	-	-	-	-	12.7
ENE	20	66	39	0	1	0	0	0	0	0	0	126
	0.5	1.5	0.9	-	0.0	-	-	-	-	-	-	2.9
E	19	63	48	2	1	0	0	1	0	0	0	134
	0.4	1.4	1.1	0.0	0.0	-	-	0.0	-	-	-	3.0
ESE	22	103	152	42	12	0	0	1	0	0	0	332
	0.5	2.3	3.4	1.0	0.3	-	-	0.0	-	-	-	7.5
SE	9	59	194	170	154	37	12	0	0	0	0	635
	0.2	1.3	4.4	3.8	3.5	0.8	0.3	-	-	-	-	14.4
SSE	5	18	95	116	245	206	58	0	0	0	0	743
	0.1	0.4	2.2	2.6	5.5	4.7	1.3	-	-	-	-	16.8
S	6	37	122	112	135	36	31	0	0	0	0	479
	0.1	0.8	2.8	2.5	3.1	0.8	0.7	-	-	-	-	10.8
SSW	7	45	137	40	20	6	1	0	0	0	0	256
	0.2	1.0	3.1	0.9	0.5	0.1	0.0	-	-	-	-	5.8
SW	3	31	88	4	4	2	0	0	0	0	0	132
	0.1	0.7	2.0	0.1	0.1	0.0	-	-	-	-	-	3.0
WSW	3	10	25	4	2	0	0	0	0	0	0	44
	0.1	0.2	0.6	0.1	0.0	-	-	-	-	-	-	1.0
W	3	9	12	4	0	0	0	0	0	0	0	28
	0.1	0.2	0.3	0.1	-	-	-	-	-	-	-	0.6
WNW	4	9	31	2	1	0	2	1	0	0	0	50
	0.1	0.2	0.7	0.0	0.0	-	0.0	0.0	-	-	-	1.1
NW	3	29	66	11	3	0	0	0	0	0	0	112
	0.1	0.7	1.5	0.2	0.1	-	-	-	-	-	-	2.5
NNW	6	38	72	3	0	0	0	0	0	0	0	119
	0.1	0.9	1.6	0.1	-	-	-	-	-	-	-	2.7
Total	406	752	1646	628	588	289	104	3	0	0	0	4416
	9.2	17.0	37.3	14.2	13.3	6.5	2.4	0.1	-	-	-	100.0

Short data : 0
Data obtained : 100.0 %

Table. 5.1.2 - 4
Frequency Distribution of Wind Direction and Velocity

Position : Pilot Station
Period : Dry Season in 1988 (1 Sep. 1988~ 1 Nov. 1988)

Dir \ m/sec	0-	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	Total
-	201 13.7											201 13.7
N	1 0.1	14 1.0	5 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	20 1.4
NNE	2 0.1	13 0.9	34 2.3	6 0.4	2 0.1	0 -	0 -	0 -	0 -	0 -	0 -	57 3.9
NE	6 0.4	26 1.8	84 5.7	11 0.8	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	128 8.7
ENE	3 0.2	19 1.3	3 0.2	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	25 1.7
E	7 0.5	11 0.8	5 0.3	1 0.1	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	25 1.7
ESE	4 0.3	33 2.3	49 3.3	8 0.5	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	95 6.5
SE	1 0.1	18 1.2	84 5.7	39 2.7	60 4.1	16 1.1	9 0.6	0 -	0 -	0 -	0 -	227 15.5
SSE	0 -	7 0.5	37 2.5	42 2.9	105 7.2	63 4.3	18 1.2	0 -	0 -	0 -	0 -	272 18.6
S	1 0.1	7 0.5	47 3.2	40 2.7	52 3.6	21 1.4	17 1.2	0 -	0 -	0 -	0 -	185 12.6
SSW	0 -	13 0.9	65 4.4	9 0.6	11 0.8	2 0.1	1 0.1	0 -	0 -	0 -	0 -	101 6.9
SW	1 0.1	9 0.6	33 2.3	0 -	2 0.1	0 -	0 -	0 -	0 -	0 -	0 -	45 3.1
WSW	0 -	3 0.2	7 0.5	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	10 0.7
W	2 0.1	2 0.1	2 0.1	1 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	7 0.5
WNW	1 0.1	4 0.3	3 0.2	0 -	0 -	0 -	1 0.1	0 -	0 -	0 -	0 -	9 0.6
NW	0 -	9 0.6	16 1.1	4 0.3	0 -	0 -	0 -	0 -	0 -	0 -	0 -	29 2.0
NNW	1 0.1	14 1.0	13 0.9	0 -	0 -	0 -	0 -	0 -	0 -	0 -	0 -	28 1.9
Total	231 15.8	202 13.8	487 33.3	161 11.0	235 16.1	102 7.0	46 3.1	0 -	0 -	0 -	0 -	1464 100.0

Short data : 0
Data obtained : 100.0 %

Table. 5.1.2 - 5
Frequency Distribution of Wind Direction and Velocity

Position : Pilot Station
Period : Dry Season in 1989 (1 May. 1989~ 1 Sep. 1989)

Dir \ m/sec	0-	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	Total
-	34 1.2											34 1.2
N	15 0.5	53 1.8	79 2.7	7 0.2	1 0.0	0 -	0 -	0 -	0 -	0 -	0 -	155 5.3
NNE	9 0.3	27 0.9	119 4.0	40 1.4	3 0.1	0 -	0 -	0 -	0 -	0 -	0 -	198 6.7
NE	28 0.9	102 3.5	244 8.3	54 1.8	3 0.1	2 0.1	0 -	0 -	0 -	0 -	0 -	433 14.7
ENE	17 0.6	47 1.6	36 1.2	0 -	1 0.0	0 -	0 -	0 -	0 -	0 -	0 -	101 3.4
E	12 0.4	52 1.8	43 1.5	1 0.0	0 -	0 -	0 -	1 0.0	0 -	0 -	0 -	109 3.7
ESE	18 0.6	70 2.4	103 3.5	34 1.2	11 0.4	0 -	0 -	1 0.0	0 -	0 -	0 -	237 8.0
SE	8 0.3	41 1.4	110 3.7	131 4.4	94 3.2	21 0.7	3 0.1	0 -	0 -	0 -	0 -	408 13.8
SSE	5 0.2	11 0.4	58 2.0	74 2.5	140 4.7	143 4.8	40 1.4	0 -	0 -	0 -	0 -	471 16.0
S	5 0.2	30 1.0	75 2.5	72 2.4	83 2.8	15 0.5	14 0.5	0 -	0 -	0 -	0 -	294 10.0
SSW	7 0.2	32 1.1	72 2.4	31 1.1	9 0.3	4 0.1	0 -	0 -	0 -	0 -	0 -	155 5.3
SW	2 0.1	22 0.7	55 1.9	4 0.1	2 0.1	2 0.1	0 -	0 -	0 -	0 -	0 -	87 2.9
WSW	3 0.1	7 0.2	18 0.6	4 0.1	2 0.1	0 -	0 -	0 -	0 -	0 -	0 -	34 1.2
W	1 0.0	7 0.2	10 0.3	3 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	21 0.7
WNW	3 0.1	5 0.2	28 0.9	2 0.1	1 0.0	0 -	1 0.0	1 0.0	0 -	0 -	0 -	41 1.4
NW	3 0.1	20 0.7	50 1.7	7 0.2	3 0.1	0 -	0 -	0 -	0 -	0 -	0 -	83 2.8
NNW	5 0.2	24 0.8	59 2.0	3 0.1	0 -	0 -	0 -	0 -	0 -	0 -	0 -	91 3.1
Total	175 5.9	550 18.6	1159 39.3	467 15.8	353 12.0	187 6.3	58 2.0	3 0.1	0 -	0 -	0 -	2952 100.0

Short data : 0
Data obtained : 100.0 %

5.1.3 Wave

1) Daily variation of significant wave

Observation of wave heights and wave directions were conducted at St.1 for a wave height observational station from 10th Sep. 1988 to 10th Sep. 1989.

Fig.5.1.3-1 are made by summarizing the daily mean value of the wave heights, such as period, daily most frequency period about significant wave and daily mean wind velocity vector.

Examining the variation of monthly mean significant wave height, the condition of wave height distribution were differ between dry and rainy season.
In the dry season, from Sep. to Oct. 1988, the wave heights were about 20cm to 50cm. They varied generally with about 25-70cm height in low conditions from May to Aug. 1989.
On the other hand, in the rainy season from Nov. 1988 to Apr. 1989, the wave heights exceeded higher than 50cm appeared in many days and were 108cm at maximum on 28th Nov. 1988.
Daily mean wave period was 3-4sec in range and not varied in large through a year.

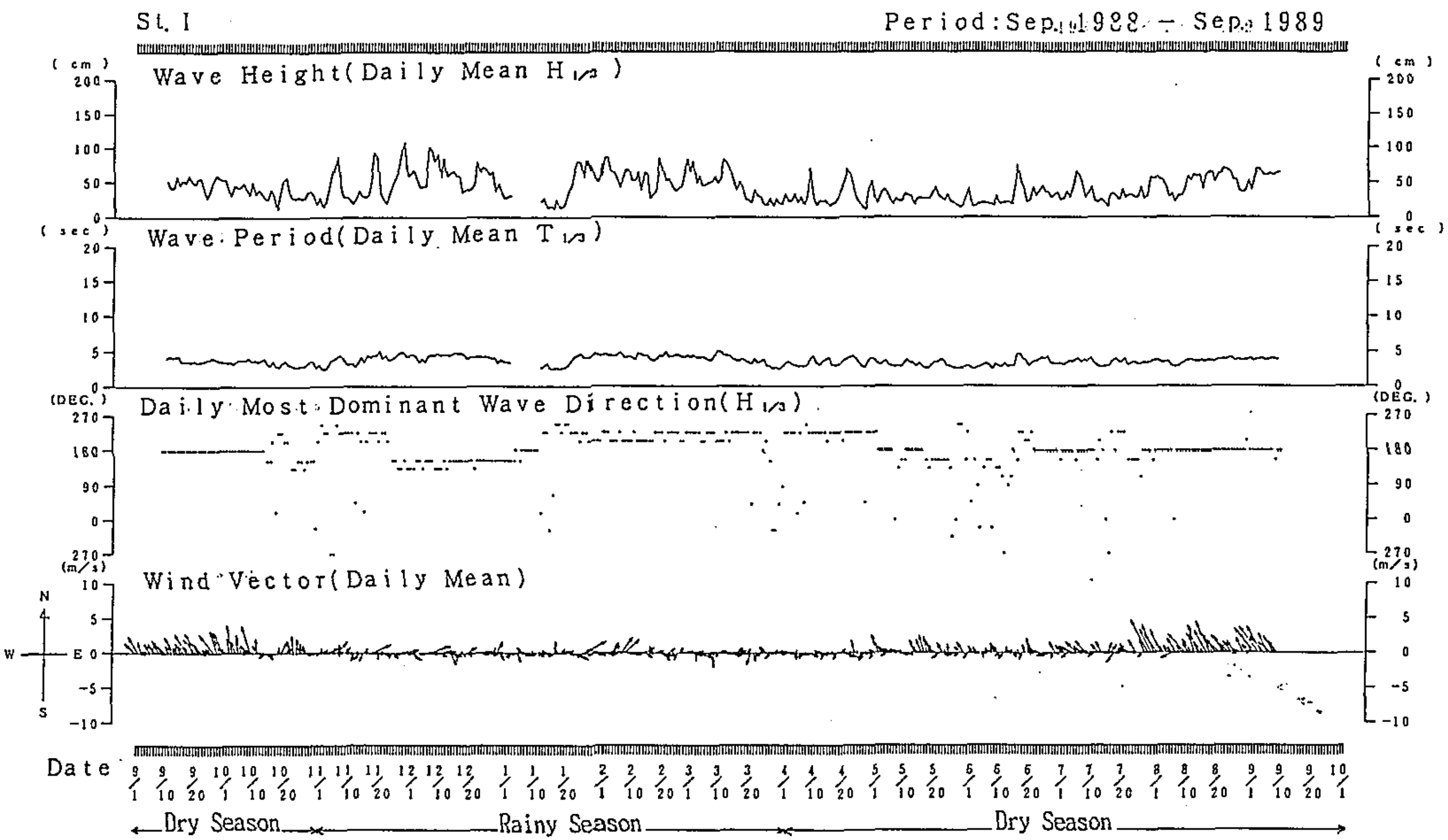


Fig. 5. 1. 3-1 Variation of Daily Mean Significant Wave(Yearlong Survey)

2) Frequency in distribution of significant wave

The observed significant waves were classified following three periods. Then the frequency in distribution of wave heights by the wave directions and the wave periods by the wave heights were shown in Fig. 5.1.3-2 to Fig.5.1.3-9 and Table 5.1.3-1, respectively.

- All seasons : 10th Sep. 1988 - 10th Sep. 1989
- Rainy season : 1st Nov. 1988 - 31st Apr. 1989
- Dry season : Combinding two dry seasons for
  1st Sep. - 31st Oct. 1988
  1st May - 31st Aug. 1989
  and each above period in two dry seasons.

These classifications were established for statistic duration.

(1) Wave height by Wave direction

According to topography map approached to the survey station, coast line in the noth side extends from ESE to WNW but submarine topography adjacent to the survey station extends rather SSW ward from Estuary of the Barito river and shows funnel shape with top at St.1.
Therefore entering direction of wave from offing are SE-W ward.

Examinig the wave height by wave direction in all seasons as shown in Fig.5.1.3-2, frequency of wave dierction occupied 45% in SSE-S and 32% in SSW-SW. Thus wave from these drections distinguished.
Wave height with 25-49cm range was most frequency in 41% and next frequency was 50-74cm range in 26%. Thus wave heights were generally low.

Examining the frequency distribution of significant wave height by wave direction in rainy season as shown in Fig.5.1.3-3, wave directions from SSW-SW were dominant with frequency 54% and next frequency with 21% was in SE-SSE. Thus wave direction from SW ward was dominant.
Wave height in this direction appeared most with 22% in range 25-49cm and next was 16% in range 50-74cm.

Examining the ferquency distribution of significant wave height by wave direction in dry season using Fig. 5.1.3-4, frequency of wave direction from SSE-S appeared distinctly with 67% . Wave height in this direction showed range 25-49cm in 32% and 50-74cm in 22%.

Comparing with distribution of wave height and frequency of wind(cf.Fig.5.1.2-2) aforementioned between rainy and dry season, in case of rainy season, wave direction from SSW-SW accorded almost with wind direction from SW-WSW.

In case of dry season, wave direction from SSE-S also accorded with wind direction from SE-SSE.
Accordingly, it seemed that wave directions in the survey sea area related closely to dominant wind in rainy and dry season.

Comparing with wave direction and wind direction, dominant wave direction deviated S'ly to one point of compass direction from dominant wave direction.
It is estimated that wave which was generated by wind in each season was converged to adjacent area of wave observational point by effect of submarine topography around margin of the Access Channel.

Wave direction among SSE-SW during the survey periods occupied 76% of whole frequencies. And Waves in souththern direction were dominant and it's frequency was 29% of whole frequency.

Examining distribution of wave height by wave direction every season, followings were found.

In the rainy season, wave in SSW-SW directions appeared extremly with 52% of whole frequency in distribution and next frequency was 23% in SSE direction. Judging from the frequencies in distribution, dominant wave directions in the rainy season were generally devided into two directions.

In the dry season, wave in SSE-S direction appeared 69% of whole frequencies including waves from southern direction with 50% of frequency.

Comparing with distributions of wave heights by wave directions in the rainy and dry season and the abovementioned the frequency in distribution of wind, dominant wind directions in each season corresponded nearly to the mode of wave height. However, dominant wave direction deviated S'ly 1 point of compass direction from dominant wind direction.
It is estimated that wave which was generated by wind in each season was converged to adjacent area of wave observational point by effect of submarine topography around margin of the access channel.

Position : St.1
Period : 10 Sep. 1988~10 Sep. 1989

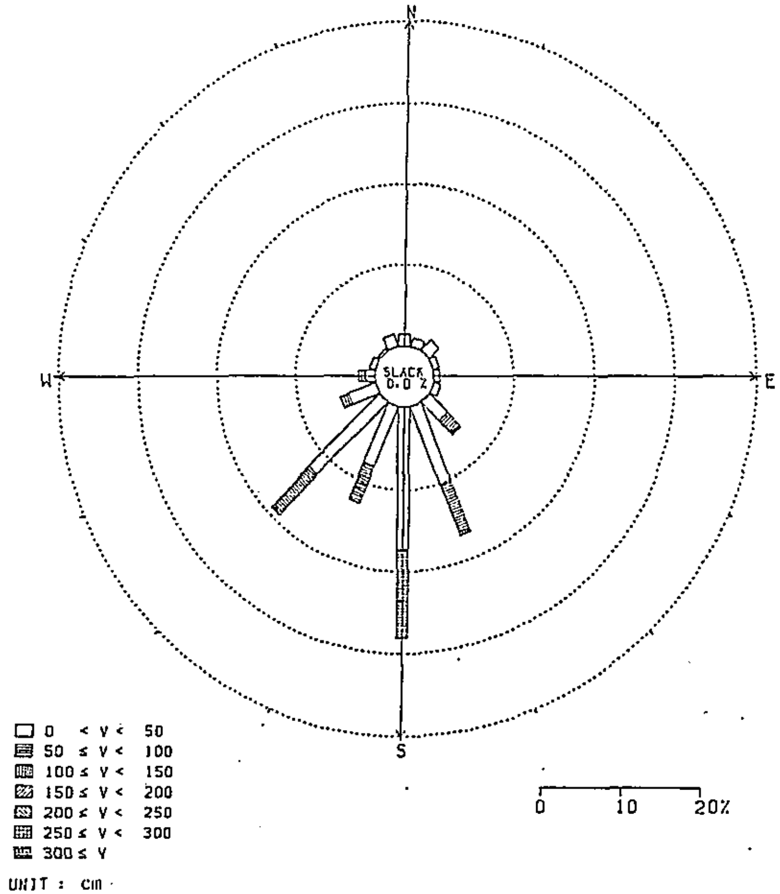


Fig. 5.1.3 − 2 Frequency Distribution of Wave Height by Wave Direction (H1/3 ; All Season)

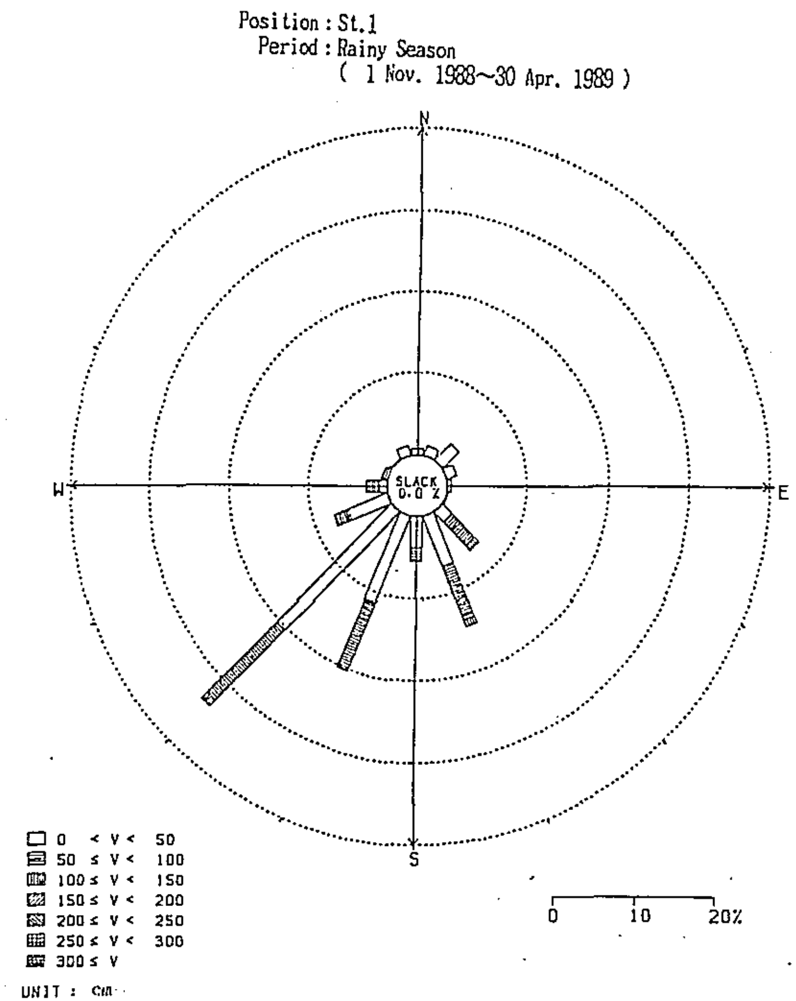


Fig. 5.1.3 – 3
Frequency Distribution of Wave Height by Wave Direction
(H1/3 ; Rainy Season)

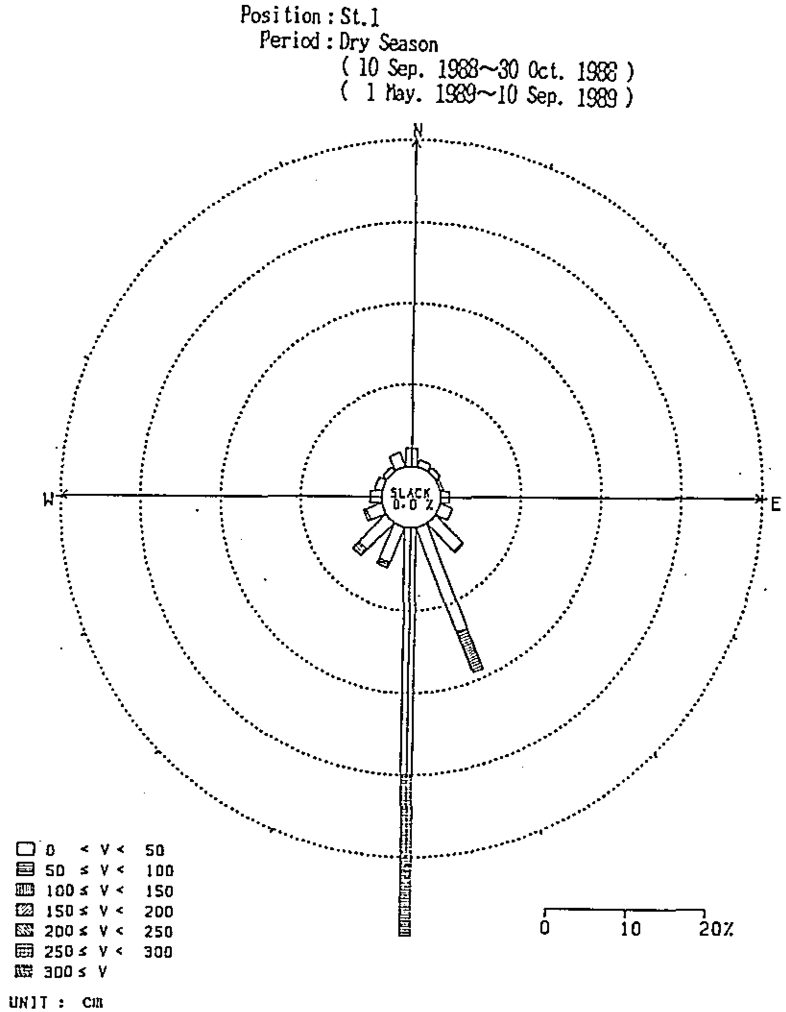


Fig. 5.1.3 – 4
Frequency Distribution of Wave Height by Wave Direction
(H1/3 ; Dry Season)

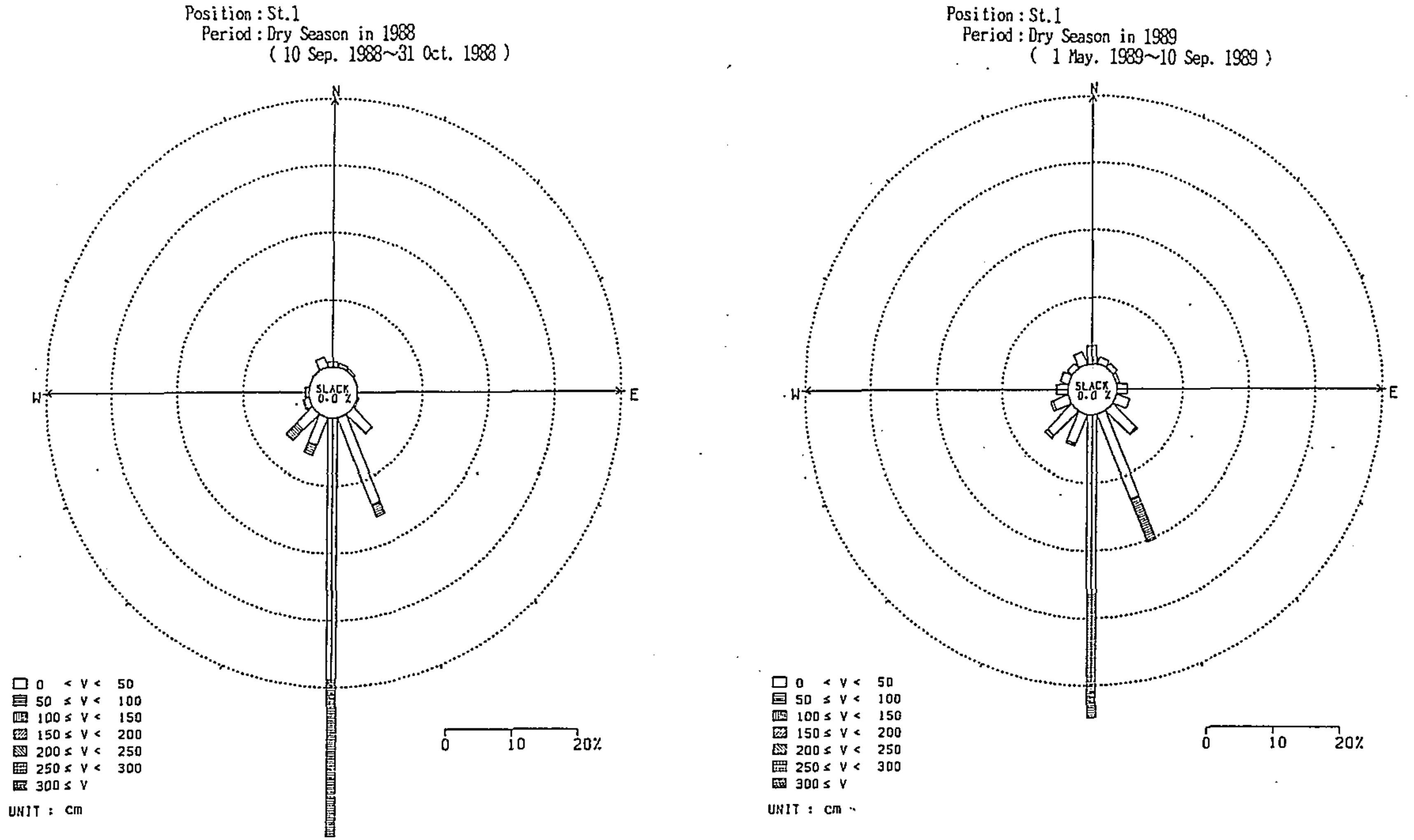


Fig. 5.1.3 − 5 Frequency Distribution of Wave Height by Wave Direction (H1/3 ; Dry Season)

(2) Wave period by wave Direction

Examining frequency distribution of wave period by wave direction through all seasons as shown in Fig. 5.1.3-6, frequencies of wave period in wave direction SSE-S were 3 sec in 26% at most and 4 sec in 15%.
In case of wind direction SSW-SW, frequency of wave period with 3 sec was 13% and with 4 sec was 15 %.
Thus frequencies of wave period differed rather according to each season.
So frequencies distribution of wave period by wave height between rainy and dry season were examined by using Fig.5.1.3-7 to Fig.5.1.3-8.
In case of dominant wave direction with SSW-SW in rainy season, frequency of wave period with 3 sec was 19% and with 4 sec was 28%. This suggested that the occured frequency of wave with long period was high in rainy season.
On the contrary, in case of dominant wave direction with SSE -S in dry season, frequency of wave period with 3 sec was 46 % and with 4 sec was 18%. Thus the occured frequency of wave with short period was high in dry season and it showed that the distribution condition of wave period between rainy ana dry season contrasted.

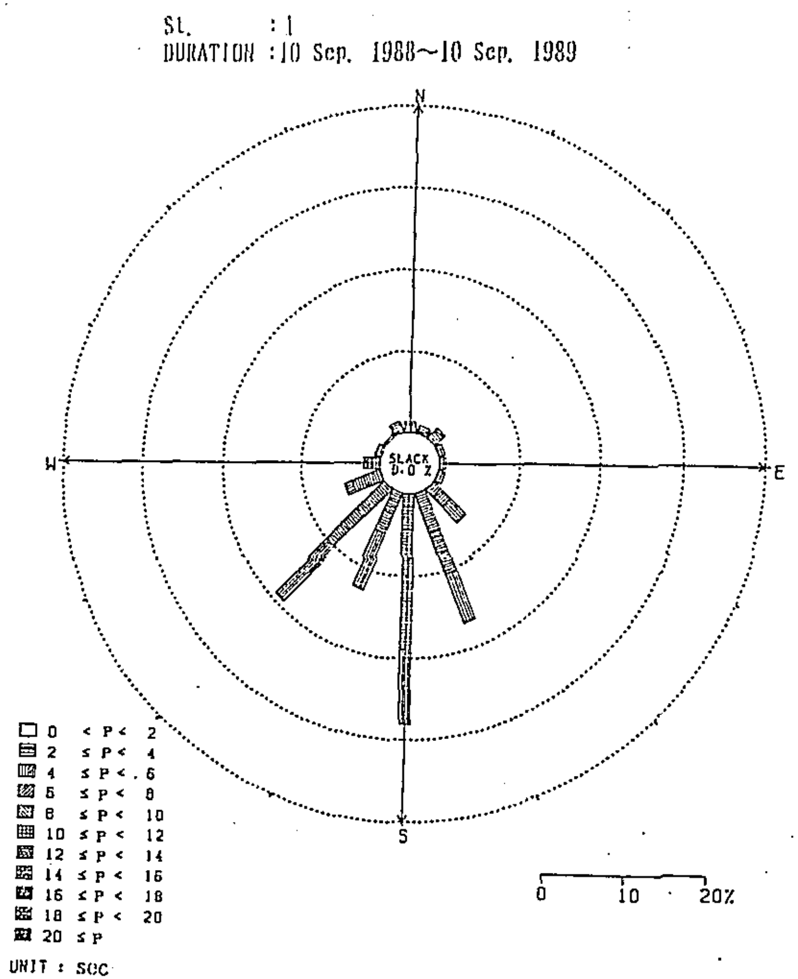


Fig. 5.1.3-6 Frequency Distribution of Wave Period by Wave Direction (All Seasons)

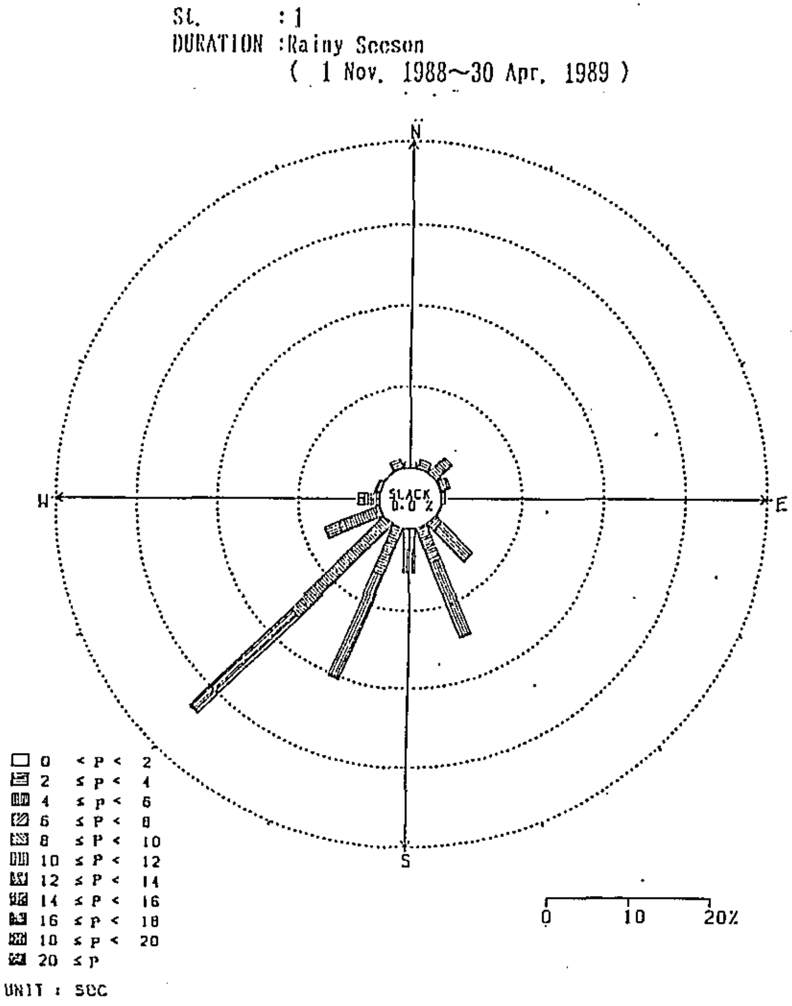


Fig. 5.1.3-7
Frequency Distribution of Wave Period by Wave Direction
(Rainy Season)

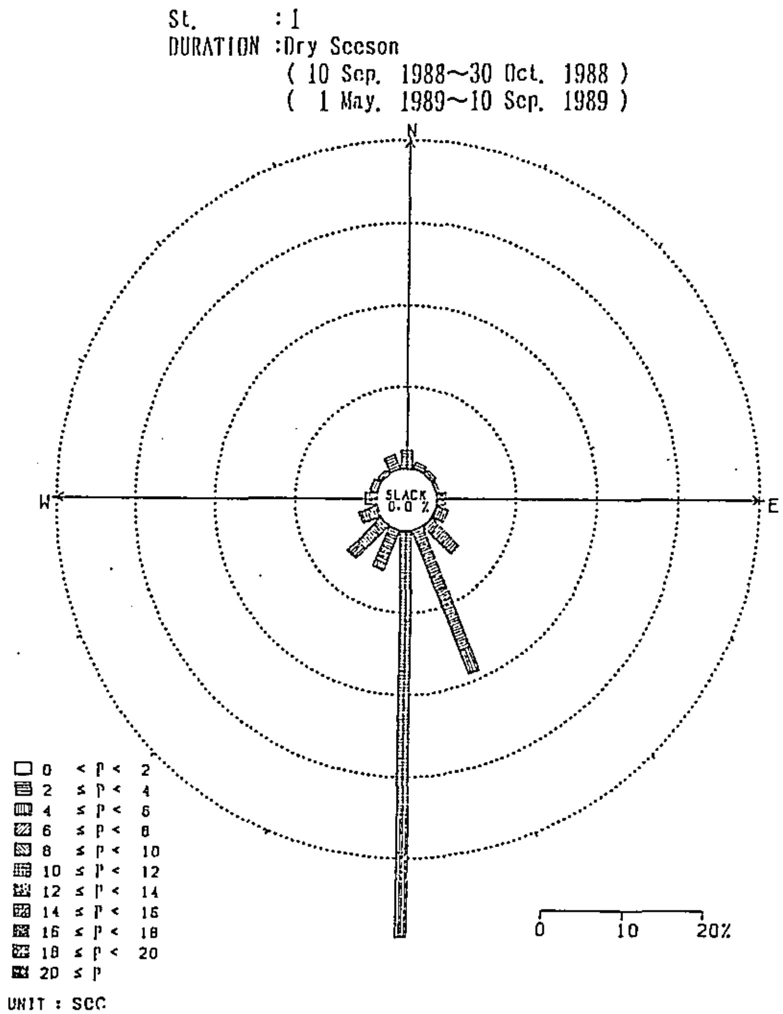
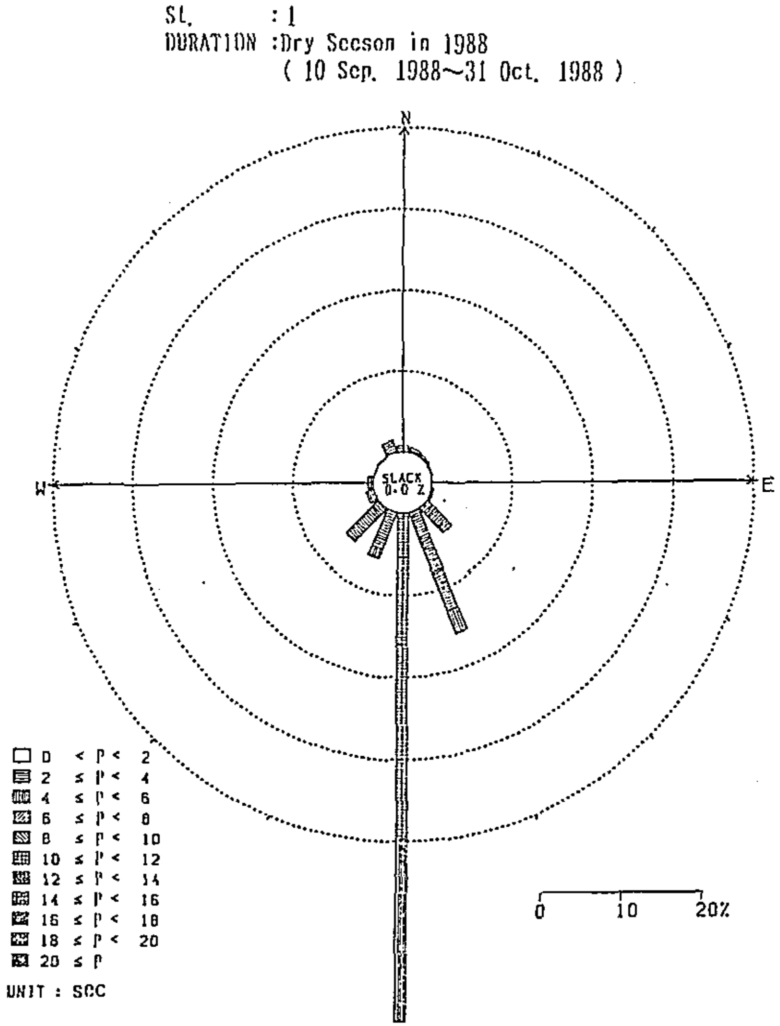


Fig. 5.1.3-8
Frequency Distribution of Wave Period by Wave Direction
(Combined Two Dry Seasons)



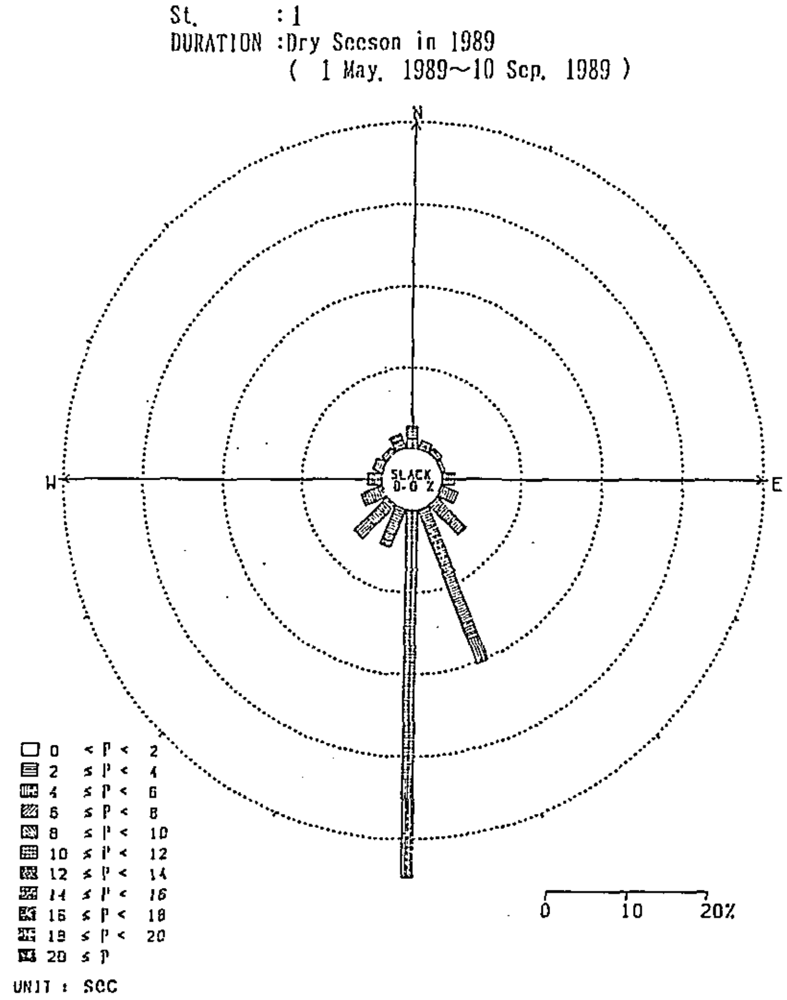


Fig. 5.1.3-9 Frequency Distribution of Wave Period by Wave Direction (1st and 2nd Dry Season)

(3) Wave period by wave height

Wave with it's period 3-4 sec appeared 79 % of whole frequencies.

Examinig relations between the height and the period, waves with period 3-4sec appeared 58% in the range of wave height rank in 25-75cm. Comparing with the periods in the rainy and dry season, followings found.

In case of wave with it's period 3-4sec and height 25-75cm, the frequency in the rainy season was 56% and it in the dry season was 59%. Both frequencies were almost same.
However, wave with period longer than 5sec appeared 6% in the rainy season and wave with long period appeared in the rainy season more than dry season.

Table. 5.1. 3 − 1(1) Frequency Distribution of Wave Height by Wave Period
(All season ; 10tn Sep. 1988-10th Sep. 1989)

Duration:10th Sep. 1988 ~ 10th Sep. 1989
St. : 1

Obtained Data	4378
Short Data	103(2.4%)

Period / Height	1.0< s	1.0~ 1.9	2.0~ 2.9	3.0~ 3.9	4.0~ 4.9	5.0~ 5.9	6.0~ 6.9	7.0~ 7.9	8.0~ 8.9	9.0~ 9.9	10.0~ 10.9	11.0~ 11.9	12.0~ 12.9	13.0~ 13.9	14.0~ 14.9	15.0~ 15.9	16.0< s	Total
<25cm			438 (10.2)	434 (10.2)	170 (4.0)	14 (0.3)												1056 (24.7)
25~ 49			331 (7.7)	890 (20.8)	504 (11.8)	48 (1.1)												1773 (41.5)
50~ 74			7 (0.2)	555 (13.0)	512 (12.0)	39 (0.9)												1113 (26.0)
75~ 99				44 (1.0)	210 (4.9)	4 (0.1)												258 (6.0)
100~ 124				2 (0.0)	45 (1.1)	8 (0.2)												55 (1.3)
125~ 149					8 (0.2)	9 (0.2)												17 (0.4)
150~ 174						2 (0.0)												2 (0.0)
175~ 199						1 (0.0)												1 (0.0)
200~ 224																		0 (0.0)
225~ 249																		0 (0.0)
250~ 274																		0 (0.0)
275~ 299																		0 (0.0)
300cm~																		0 (0.0)
Total	0 (0.0)	0 (0.0)	776 (18.2)	1925 (45.0)	1449 (33.9)	125 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4275 (100.0)

Note : Upper layer shows Frequencies and Lower layer shows Frequencies in % .

Table. 5.1. .3 − 1(2) Frequency Distribution of Wave Height by Wave Period
(Rainy season ; 1st Nov. 1988-30th Apr. 1989)

Duration: 1st Nov. 1988 ~ 30th Apr. 1989
St. : 1

Obtained Data	2172
Short Data	101(4.7%)

Period / Height	1.0< s	1.0~ 1.9	2.0~ 2.9	3.0~ 3.9	4.0~ 4.9	5.0~ 5.9	6.0~ 6.9	7.0~ 7.9	8.0~ 8.9	9.0~ 9.9	10.0~ 10.9	11.0~ 11.9	12.0~ 12.9	13.0~ 13.9	14.0~ 14.9	15.0~ 15.9	16.0< s	Total
<25cm			200 (9.7)	174 (8.4)	68 (3.3)	8 (0.4)												450 (21.7)
25~ 49			113 (5.5)	319 (15.4)	309 (14.9)	45 (2.2)												786 (38.0)
50~ 74			3 (0.1)	148 (7.1)	387 (18.7)	36 (1.7)												574 (27.7)
75~ 99				16 (0.8)	169 (8.2)	4 (0.2)												189 (9.1)
100~ 124				1 (0.0)	43 (2.1)	8 (0.4)												52 (2.5)
125~ 149					8 (0.4)	9 (0.4)												17 (0.8)
150~ 174						2 (0.1)												2 (0.1)
175~ 199						1 (0.0)												1 (0.0)
200~ 224																		0 (0.0)
225~ 249																		0 (0.0)
250~ 274																		0 (0.0)
275~ 299																		0 (0.0)
300cm~																		0 (0.0)
Total	0 (0.0)	0 (0.0)	316 (15.3)	658 (31.8)	984 (47.5)	113 (5.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2071 (100.0)

Note : Upper layer shows Frequencies and Lower layer shows Frequencies in % .

Table. 5.1. 3－1(3) Frequency Distribution of Wave Height by Wave Period

(Dry season ; 10th Sep.-31th Oct. 1988 & 1st May-10th Sep. 1989)

Duration:10th Sep. 1988 ~ 10th Sep. 1989
St. : 1

Obtained Data	2206
Short Data	2 (0.1%)

Period / Height	1.0< s	1.0~ 1.9	2.0~ 2.9	3.0~ 3.9	4.0~ 4.9	5.0~ 5.9	6.0~ 6.9	7.0~ 7.9	8.0~ 8.9	9.0~ 9.9	10.0~ 10.9	11.0~ 11.9	12.0~ 12.9	13.0~ 13.9	14.0~ 14.9	15.0~ 15.9	16.0< s	Total
<25cm			238 (10.8)	260 (11.8)	102 (4.6)	6 (0.3)												606 (27.5)
25~ 49			218 (9.9)	571 (25.9)	195 (8.8)	3 (0.1)												987 (44.8)
50~ 74			4 (0.2)	407 (18.5)	125 (5.7)	3 (0.1)												539 (24.5)
75~ 99				28 (1.3)	41 (1.9)													69 (3.1)
100~ 124				1 (0.0)	2 (0.1)													3 (0.1)
125~ 149																		0 (0.0)
150~ 174																		0 (0.0)
175~ 199																		0 (0.0)
200~ 224																		0 (0.0)
225~ 249																		0 (0.0)
250~ 274																		0 (0.0)
275~ 299																		0 (0.0)
300cm~																		0 (0.0)
Total	0 (0.0)	0 (0.0)	460 (20.9)	1267 (57.5)	465 (21.1)	12 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2204 (100.0)

Note : Upper layer shows Frequencies and Lower layer shows Frequencies in % .

Table. 5.1. 3－1(4) Frequency Distribution of Wave Height by Wave Period

(Dry season)

Duration:10th Sep. ~ 31th Oct. 1988
St. : 1

Obtained Data	618
Short Data	1 (0.2%)

Period / Height	1.0< s	1.0~ 1.9	2.0~ 2.9	3.0~ 3.9	4.0~ 4.9	5.0~ 5.9	6.0~ 6.9	7.0~ 7.9	8.0~ 8.9	9.0~ 9.9	10.0~ 10.9	11.0~ 11.9	12.0~ 12.9	13.0~ 13.9	14.0~ 14.9	15.0~ 15.9	16.0< s	Total
<25cm			33 (5.3)	45 (7.3)	27 (4.4)													105 (17.0)
25~ 49			43 (7.0)	190 (30.8)	95 (15.4)													328 (53.2)
50~ 74			1 (0.2)	132 (21.4)	43 (7.0)	1 (0.2)												177 (28.7)
75~ 99				3 (0.5)	3 (0.5)													6 (1.0)
100~ 124				1 (0.2)														1 (0.2)
125~ 149																		0 (0.0)
150~ 174																		0 (0.0)
175~ 199																		0 (0.0)
200~ 224																		0 (0.0)
225~ 249																		0 (0.0)
250~ 274																		0 (0.0)
275~ 299																		0 (0.0)
300cm~																		0 (0.0)
Total	0 (0.0)	0 (0.0)	77 (12.5)	371 (60.1)	168 (27.2)	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	617 (100.0)

Note : Upper layer shows Frequencies and Lower layer shows Frequencies in % .

Table. 5.1. 3－1(5) Frequency Distribution of Wave Height by Wave Period

(Dry season)

Duration: 1st May ~ 10th Sep. 1989
St. : 1

Obtained Data	1588
Short Data	1 (0.1%)

Period / Height	1.0< s	1.0~ 1.9	2.0~ 2.9	3.0~ 3.9	4.0~ 4.9	5.0~ 5.9	6.0~ 6.9	7.0~ 7.9	8.0~ 8.9	9.0~ 9.9	10.0~ 10.9	11.0~ 11.9	12.0~ 12.9	13.0~ 13.9	14.0~ 14.9	15.0~ 15.9	16.0< s	Total
<25cm			205 (12.9)	215 (13.5)	75 (4.7)	6 (0.4)												501 (31.6)
25~ 49			175 (11.0)	381 (24.0)	100 (6.3)	3 (0.2)												659 (41.5)
50~ 74			3 (0.2)	275 (17.3)	82 (5.2)	2 (0.1)												362 (22.8)
75~ 99				25 (1.6)	38 (2.4)													63 (4.0)
100~ 124					2 (0.1)													2 (0.1)
125~ 149																		0 (0.0)
150~ 174																		0 (0.0)
175~ 199																		0 (0.0)
200~ 224																		0 (0.0)
225~ 249																		0 (0.0)
250~ 274																		0 (0.0)
275~ 299																		0 (0.0)
300cm~																		0 (0.0)
Total	0 (0.0)	0 (0.0)	383 (24.1)	896 (56.5)	297 (18.7)	11 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1587 (100.0)

Note : Upper layer shows Frequencies and Lower layer shows Frequencies in % .

3) Maximum wave height during survey

Maximum ten(10) waves in each season which were observed every 2 hours through 10th Sep. 1988 to 10th Sep. 1989, were extracted. The eaxtracted waves were placed orderly with significant wave heighis, wave directions and wind and were shown in Table 5.1.3-2.
And Variation of Significant Wave(H1/3) in the month when maximum wave height appeared with the occured date were shown in Fig.5.1.3-10 and Fig.5.1.3-11.

Each season and duration are as follows;

Rainy season : Nov.1988 - Apr. 1989

Dry season : Sep.1988 - Oct. 1988 and May 1989 - Sep.1989

(1) Rainy season

Maximum wave height in rainy season occured at 18 o'clock on 27th Nov.1988 with the height 268cm and period 6.5sec. High wave and swell in this time began at around 14 o'clock on the same day and it's peak appeared after 4 hours. After then the high wave condition with the height 180cm continued until 6 o'clock on next morining. Further, this high wave conditions continued until 0 o'clock on 29th Nov. showing disturbances among wave heights. This continuous duration were about 32 hours.
Contrasting wind data in this term, two(2) hours before maximum wave occured it had been recorded wind direction WSW and it's velocity 7.9m/s and during high wave and swell appeared WSW'ly wind with it's velocity higher than 5m/s blew continuously.

(2) Dry season

Maximum wave height in dry season occured at 22 o'clock on 17th June 1989. The height was 186cm with period 4sec. High wave and swell in this time occured suddenly and stoped about 6 hours later. Wind in this time was the direction N and the velocity with 1m/s and correlation between wave and wind were not seen.
Same cases happened often at survey site. It is estimated that this condition are caused by local depression or passing front. Other reason may be caused by turbulence in the atomosphere in micro-scale because distance between wind and wave height observational station is 17km far away and is difficult to accord between both records.

Table 5.1.3-2(1) List of Maximum Wave Height in Rainy Season(1st Nov. 1988-31th April 1989)

Rank	Date	Hmax. Height cm	Hmax. Period sec	H1/3 Height cm	H1/3 Period sec	Wave Dir.	Wind Dir.	Wind Vel. m/s	Continuous duration for significant wave height heigher than 1m
1.	18h 27th Nov. 1988	268	6.5	172	5.8	S E	WSW	5.1	32h
2.	2h 7th Dec. 1988	232	5.0	129	4.8	SSE	WNN	4.0	18h
3.	20h 20th Feb. 1989	224	5.5	127	4.8	S W	N W	2.5	4h
4.	16h 18th Nov. 1988	222	4.0	130	4.9	SSW	WSW	3.0	4h
5.	2h 25th Jan. 1989	219	6.5	150	5.7	S W	WNW	3.0	2h
6.	10h 1st Feb. 1989	211	6.0	139	5.0	S W	WNW	3.0	6h
7.	18h 11th Dec. 1988	202	5.0	120	5.0	S	WSW	5.0	4h
8.	18h 25th Dec. 1988	198	5.0	130	4.6	SSE	S W	5.0	-
9.	12h 9th Dec. 1988	196	5.0	132	5.3	S E	WSW	4.5	8h
10.	4h 6th Nov. 1988	191	4.0	98	4.2	W	WSW	2.0	4h

Table 5.1.3-2(2) List of Maximum Wave Height in Dry Season(10th Sep.-31th Oct. 1989 and 1st May-10th Sep. 1989)

Rank	Date	Hmax. Height cm	Hmax. Period sec	H1/3 Height cm	H1/3 Period sec	Wave Dir.	Wind Dir.	Wind Vel. m/s	
1.	22h 17th June 1989	186	4.0	95	4.0	WSW	N	1.0	32h
2.	20h 15th June 1989	186	4.0	93	3.9	S	W	3.5	18h
3.	16h 9th Sep. 1989	178	3.5	87	4.1	S	SSE	6.2	4h
4.	18h 2th Sep. 1989	168	5.0	96	4.2	S	SSE	6.0	4h
5.	16h 3th Sep. 1989	164	3.5	85	3.9	S	SSE	7.0	2h
6.	22h 15th Oct. 1988	163	4.0	103	3.8	S W	N W	2.0	6h
7.	16h 16th June 1989	156	4.5	107	4.7	S W	S W	5.0	4h
8.	18h 1th Sep. 1989	151	3.5	80	3.9	S	S E	6.3	-
9.	18h 24th Aug. 1989	145	4.5	88	4.3	W	S E	4.4	8h
10.	8h 30th Aug. 1989	141	3.5	93	4.0	S	N W	2.8	4h

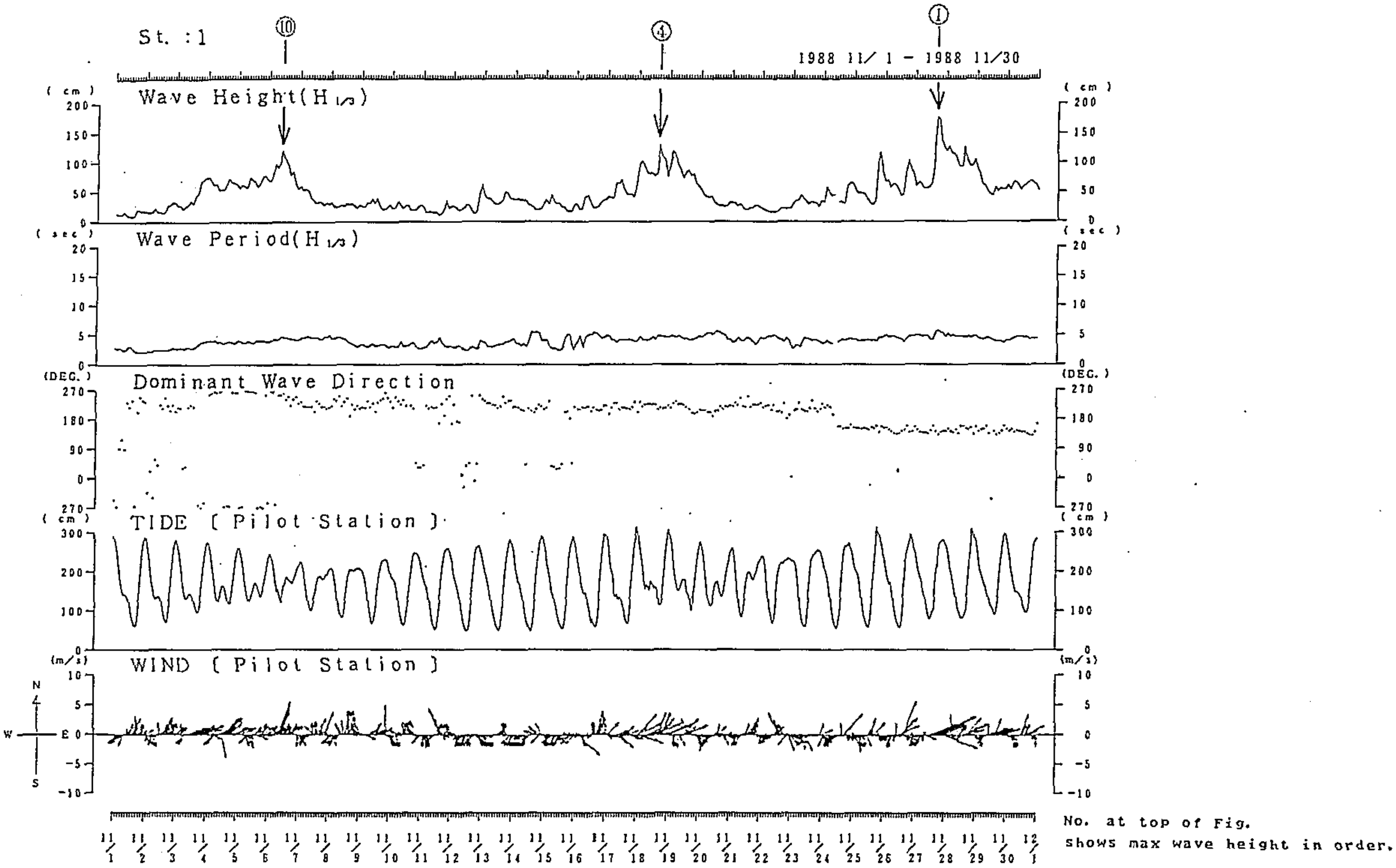


Fig. 5.1.3-10 (1) Variation of Significant Wave(H 1/3) (Rainy Season)

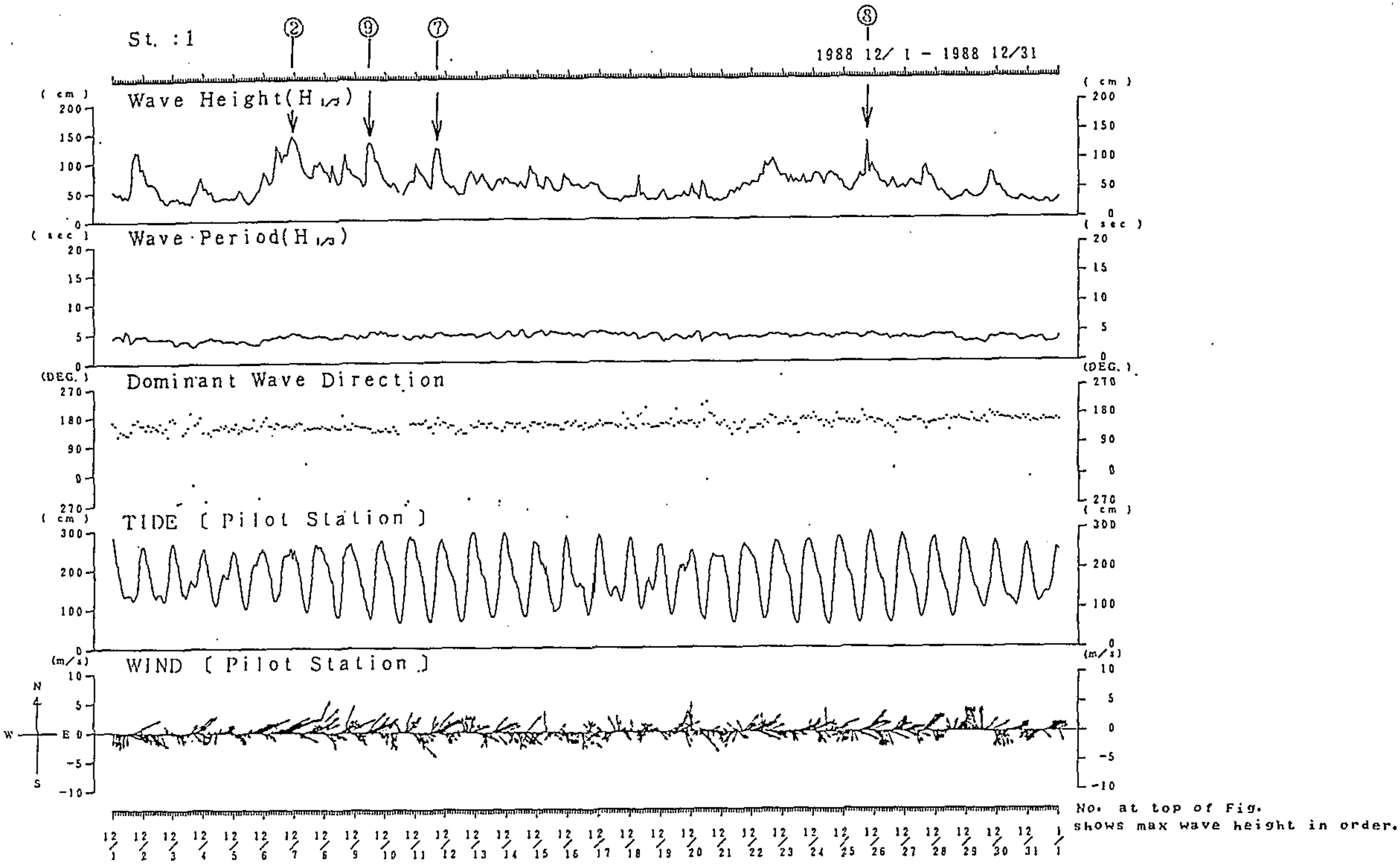


Fig. 5.1.3 −10 (2) Variation of Significant Wave($H_{1/3}$) (Rainy Season)

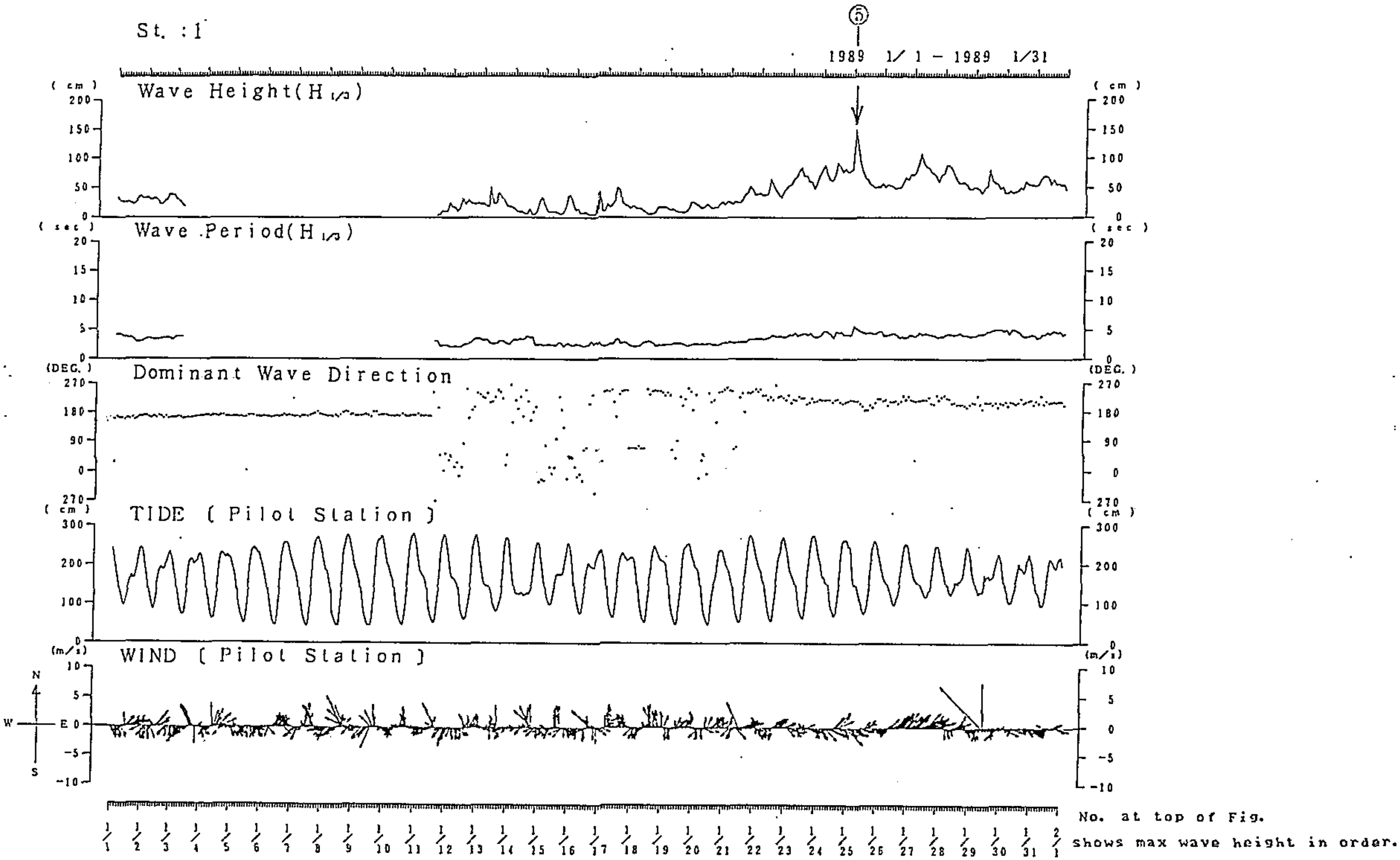


Fig. 5.1.3-10 (3) Variation of Significant Wave(H 1/3) (Rainy Season)

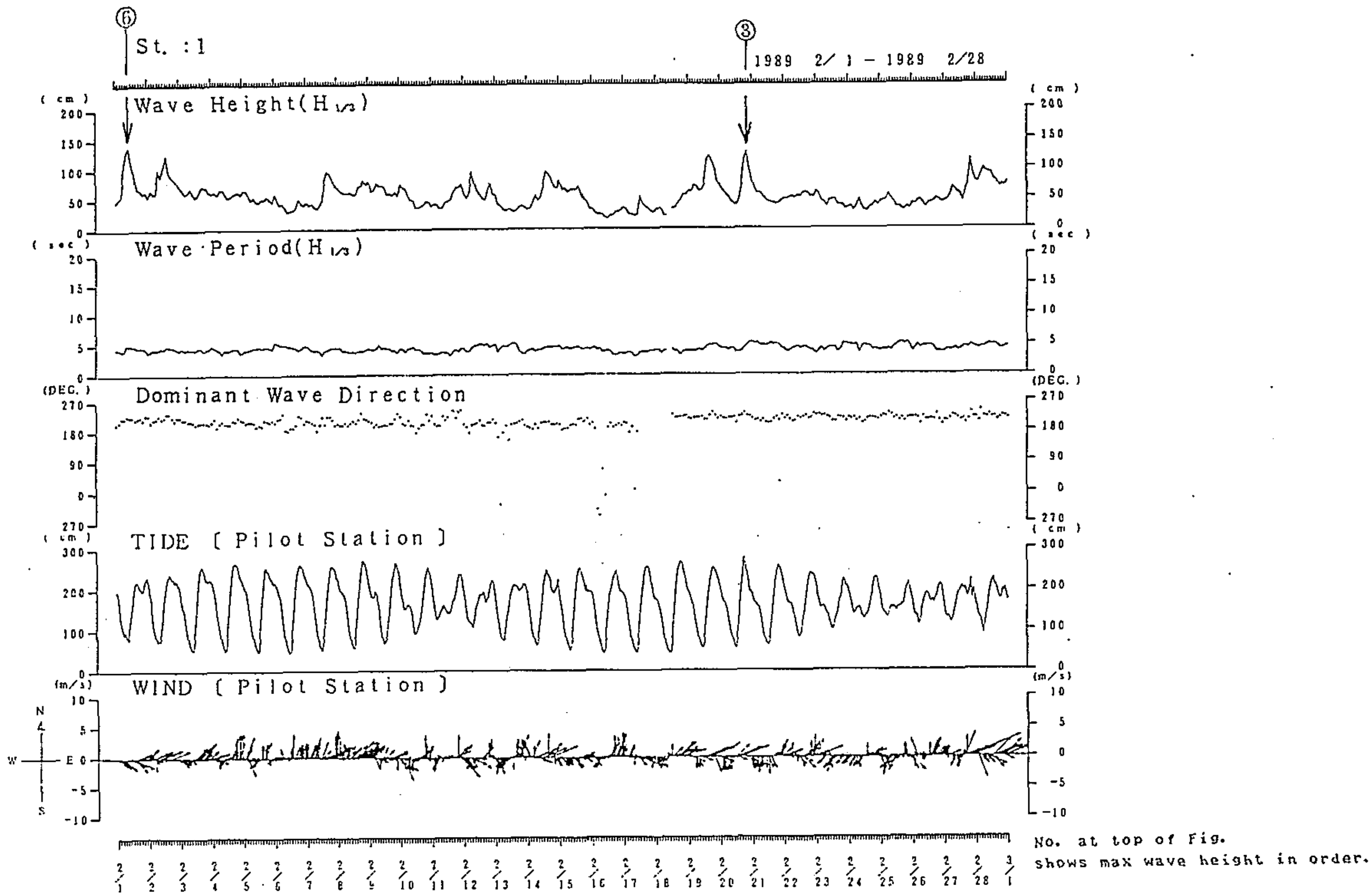
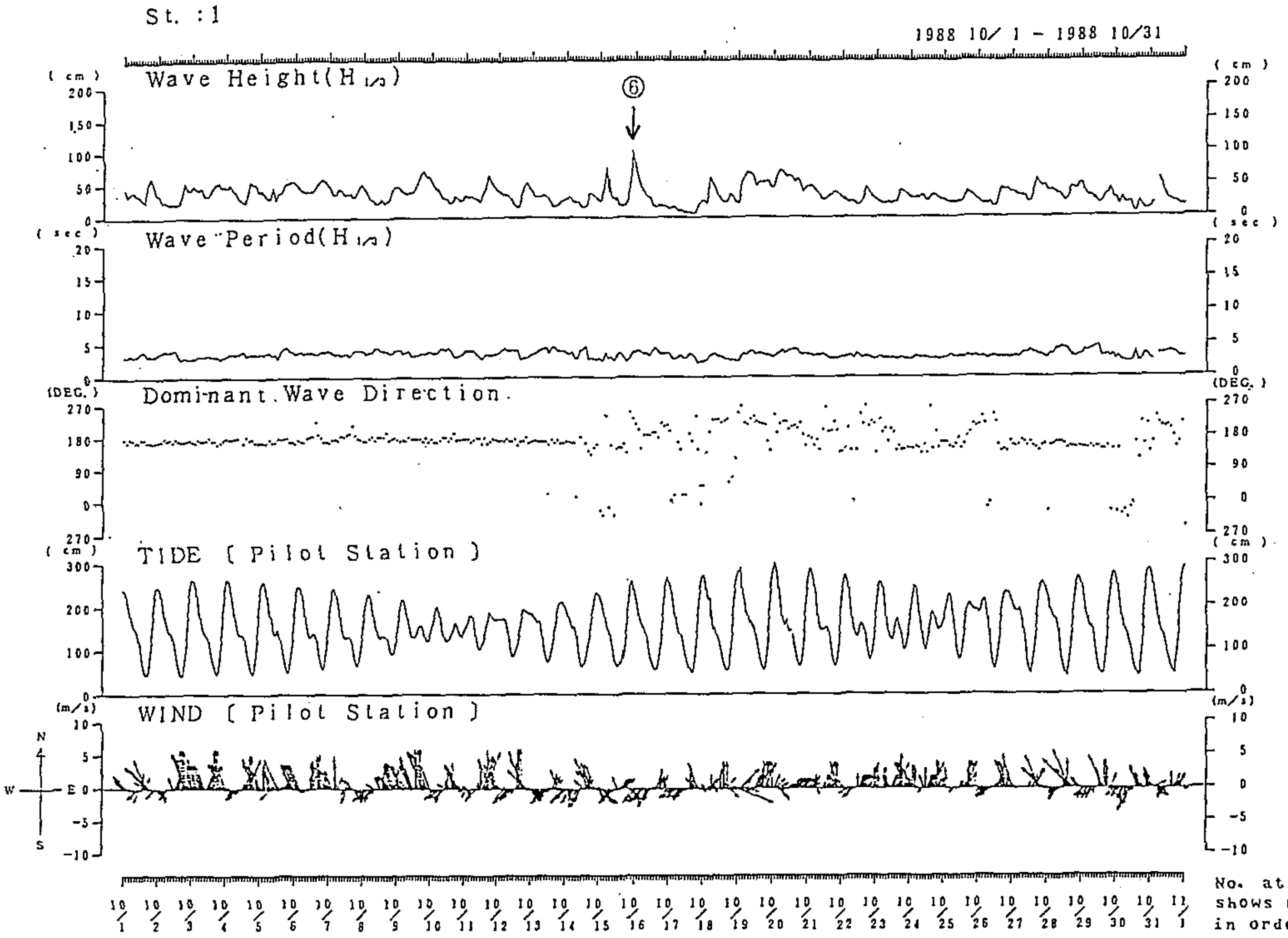


Fig. 5.1.3-10 (4) Variation of Significant Wave($H_{1/3}$) (Rainy Season)



No. at top of Fig. shows max wave height in order.

Fig. 5.1.3-11 (1) Variation of Significant Wave($H_{1/3}$) (Dry Season)

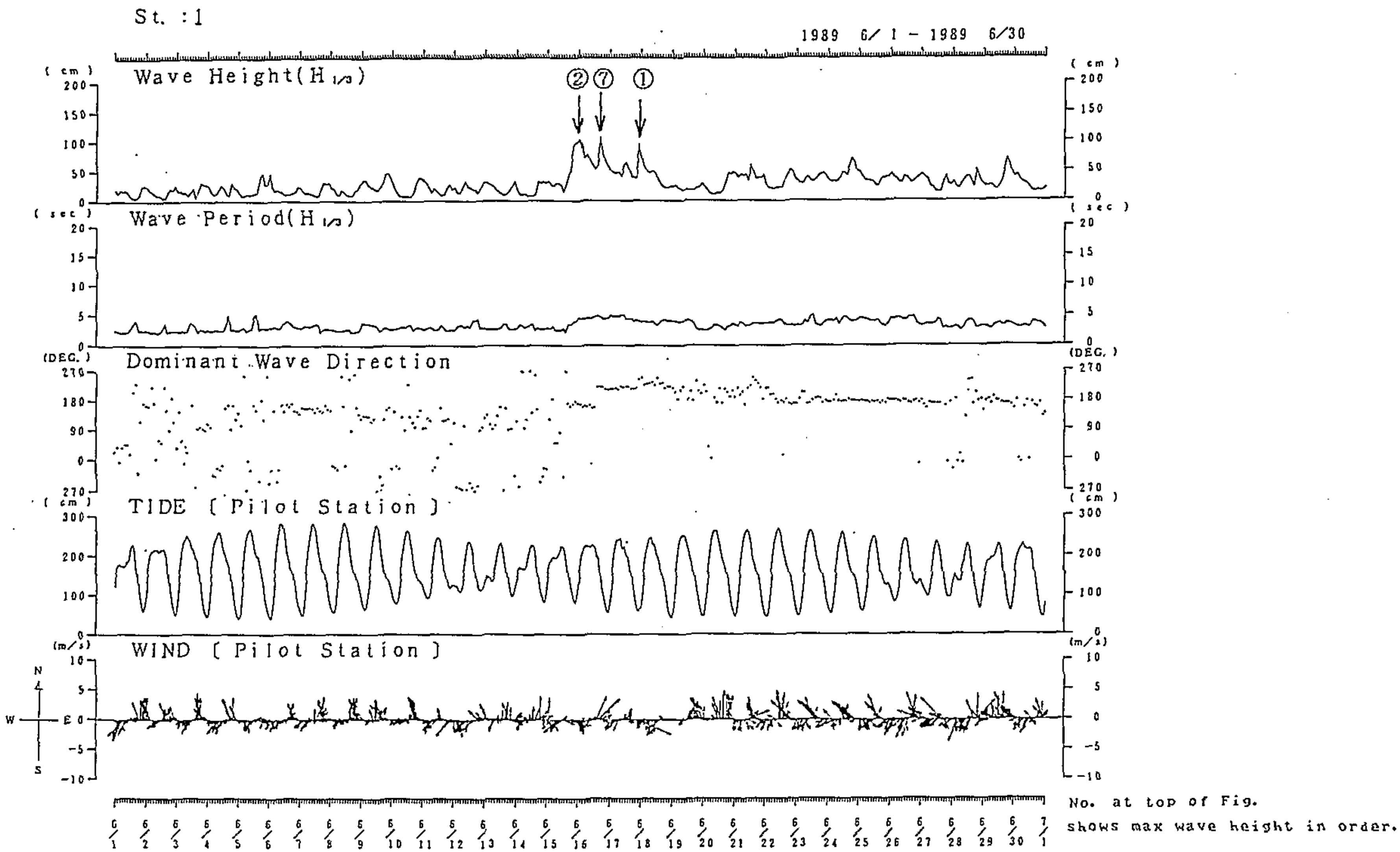


Fig. 5.1.3-11 (2) Variation of Significant Wave(H 1/3) (Dry Season)

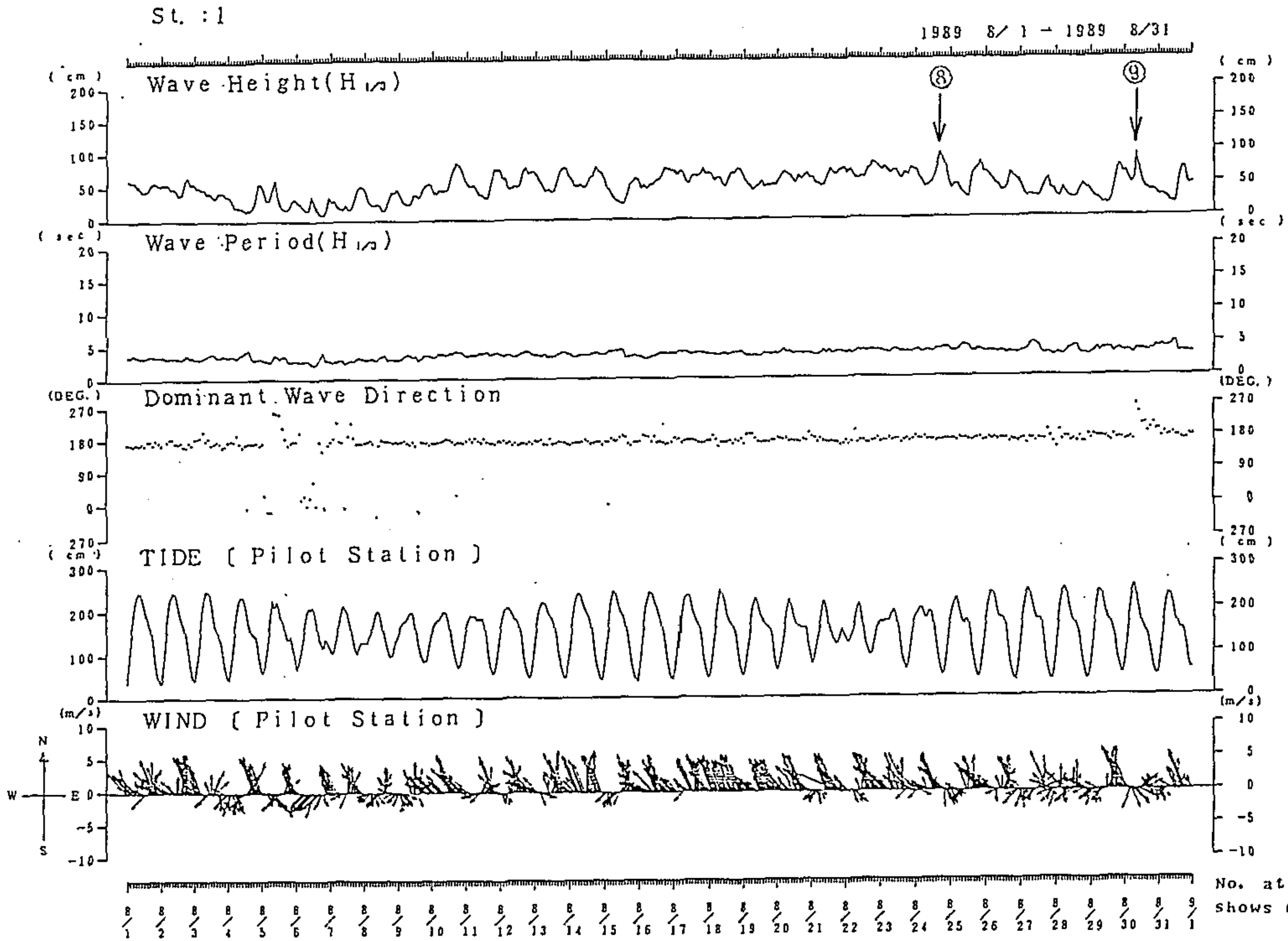
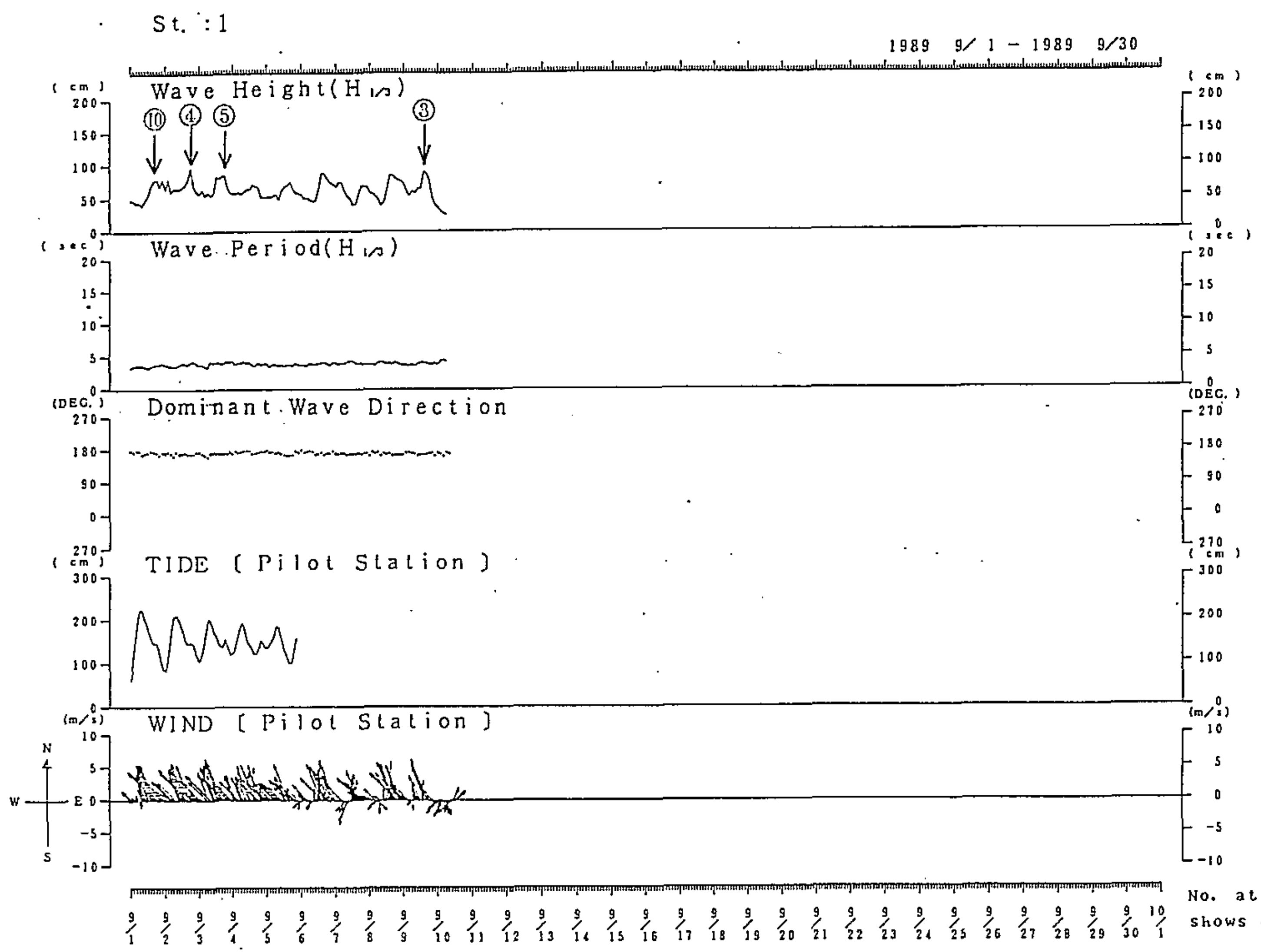


Fig. 5.1.3-11(3) Variation of Significant Wave($H_{1/3}$) (Dry Season)



No. at top of Fig.
shows max wave height in order.

Fig. 5.1.3 -11 (4) Variation of Significant Wave($H_{1/3}$) (Dry Season)

5.2 Monthly Survey

5.2.1 River Discharge

River Discharge Surveys in the Barito River were carried out from September 1988 to August 1989 with average one time per a month and total twelve times.

The survey date and time are shown in under table.

Table Date and Time of River Discharge Survey

Stage		Date and Time		
1st stage	;	23th(11:00)-24th(11:00)	Sep.	1988
2nd stabe	;	19th(10:00)-20th(10:00)	Nov.	1988
3rd stage	;	6th(14:00)- 7th(14:00)	Dec.	1988
4th stage	;	7th(09:00)- 8th(09:00)	Jan.	1989
5th stage	;	9th(09:00)- 9th(09:00)	Feb.	1989
6th stage	;	23th(10:00)-24th(10:00)	March	1989
7th stage	;	26th(09:00)-27th(09:00)	April	1989
8th stage	;	25th(09:00)-26th(09:00)	May	1989
9th stage	;	20th(09:00)-21th(09:00)	June	1989
10th stage	;	14th(10:00)-15th(10:00)	July	1989
11th stage	;	30th(09:00)-31th(09:00)	July	1989
12th stage	;	13th(09:00)-14th(09:00)	Aug.	1989

1) Rainfall

Examining the annual variation of the rainfall around stream area of the Barito River, existing rainfall data were collected for Muara Uya as an upper stream area, Pantai Hambawang as a middle stream area and Banjarmasin as a down stream area.
Variation of monthly mean rainfall which was made by the aforementioned data from September 1988 to August 1989 and data since about ten years are shown in Fig. 5.2.1-1.

According to Fig.5.2.1-1, maximum monthly mean rainfall at each station were 309 mm at Muara Uya in December, 326 mm at Pantai Hambawang in December and 378 mm at Banjarmasin in January.
A tendency of rainfall at Banjarmasin was rather much comparing with other two stations.
However, maximum monthly rainfall through September 1988 to August 1989 was 826 mm at Muara Uya in December and was 387 mm at Pantai Hambawang in November and was 363 mm at Banjarmasin in November.

Comparing with these three stations, rainfall at Muara Uya distinguished from other two stations with two times of each rainfall.
To the contrary, rainfalls from September to December 1988 at Pantai Hambawang and Banjarmasin were ordinary orders.

Examining rainfalls at both stations after December 1988, the tendencies were rather less than past ten years monthly mean rain fall.
It was concluded that rainfalls in 1988 distinguished sharply among stations.

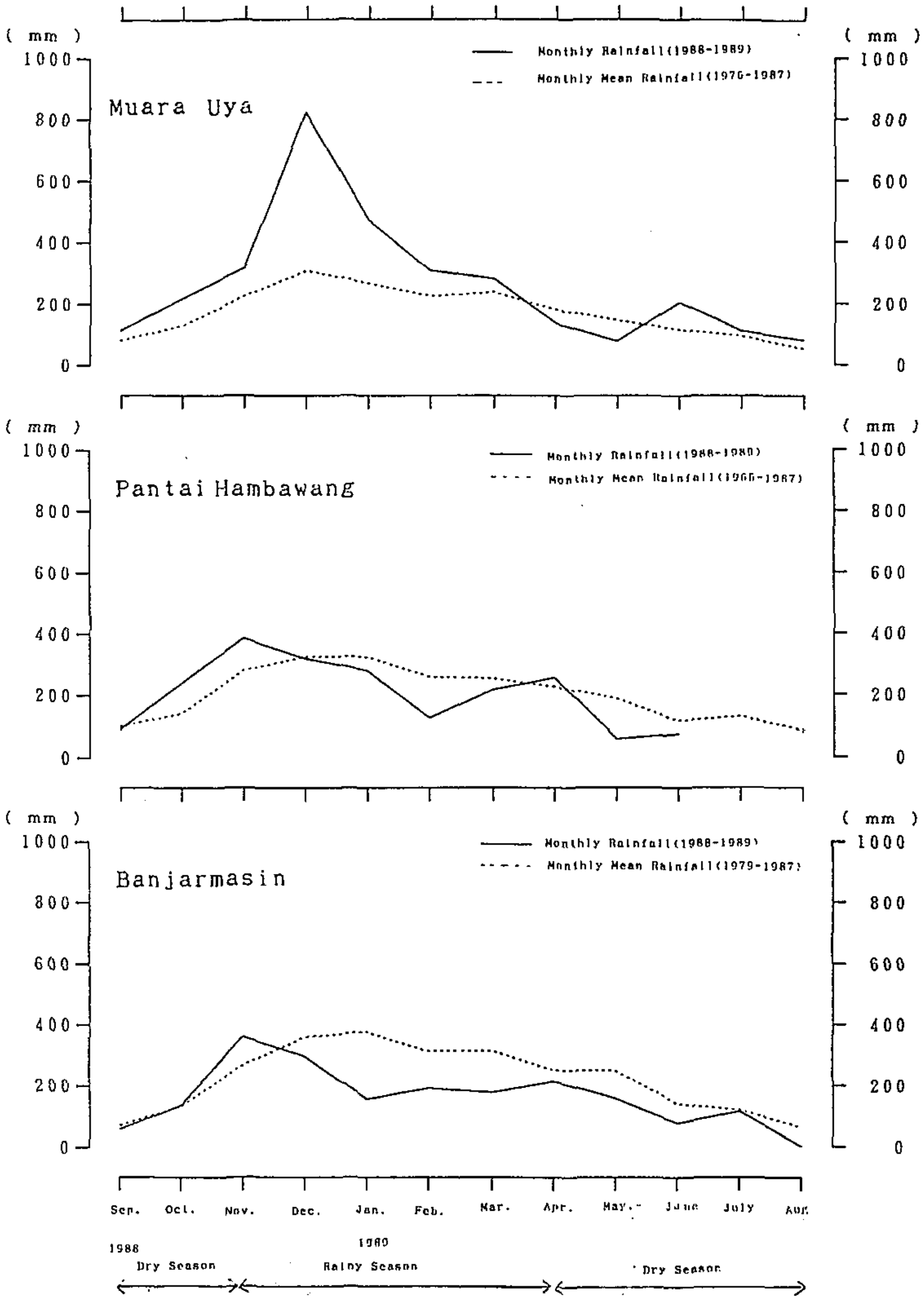


Fig. 5.2.1-1(1) Variation of Rainfall

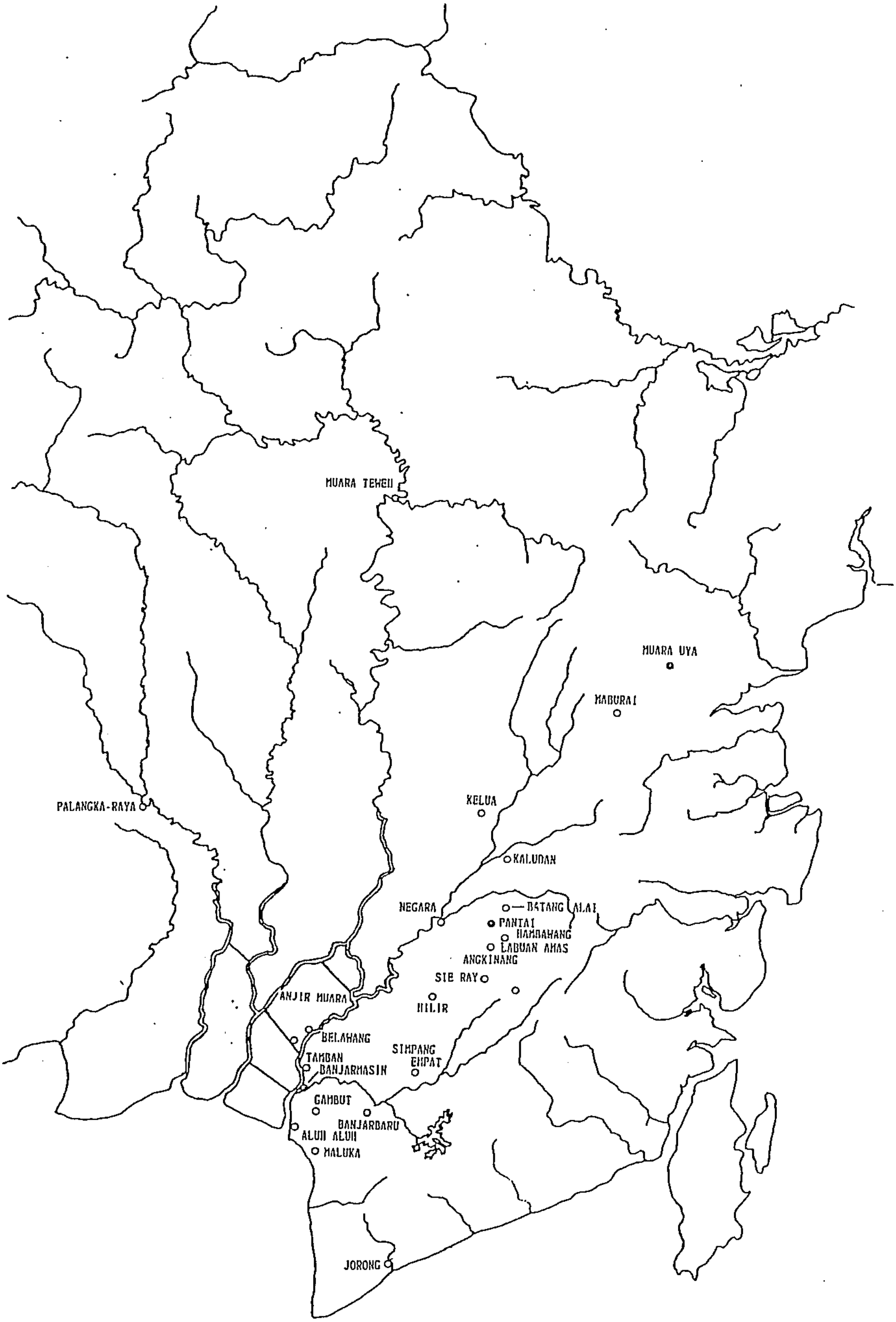


Fig. 5. 2. 1-1(2) Station Map for Existing Rainfall Data

2)Daily Mean River Discharge Volume

Examinig the Variation of River Discharge Volume for a year, Daily Mean River Discharge Volume in Time Sereis was shown in Fig.5.2.1-2.
Tranportation Quantity of Suspended Materials conversed from SS and mean water levels at tide pole in Trisakti(mean value at time conducting River Water Discharge Survey) and Monthly Mean Tide Level at Pilot Station were also shown in Fig.5.2.1-2.
Daily Mean River Discharge Volume called in here means the averaged discharge volume which was obtained from River Discharge Survey(25 hours continuous observation).

According to the result, Daily Mean Discharge Volume which was 3210m3/s in September increased with starting rainy season and became 4589m3/s in December. This value was maximum.
But in spite of rainy season from January to February, the River Discharge Volume decreased sharply and showed 2199 m3/s in February. This value was less than a half of volume in December.
The volume began to increased again from March, second peak appeared with 3731m3/s in April.
After May, as it changed to dry season from rain,the volume decreased gradually and it's minimum appeared with 731m3/s in August.
Mean River Discharge Volume for a year which was obtained from Daily Mean River Discharge Volume through 12 stages was 2650m3/s.

As for daily mean water level, it rised with starting rainny season and it's maximum appeared in December.
The level descended sharply about 30 cm in January and then showed a tendency of rising in April and May. After then the level descended and showed minimum in August.
Variation of Daily Mean water Level showed no big difference compareing with the monthly mean level at Pilot Station.
Daily mean River Discharge Volume generally varied with the aforementioned Variation of Daily Mean Water Level but when the volume decreased in January and February or increased again in March and April, both not always showed well relation.
It suggested that there were complex characteristic of current variation in the Barito River.

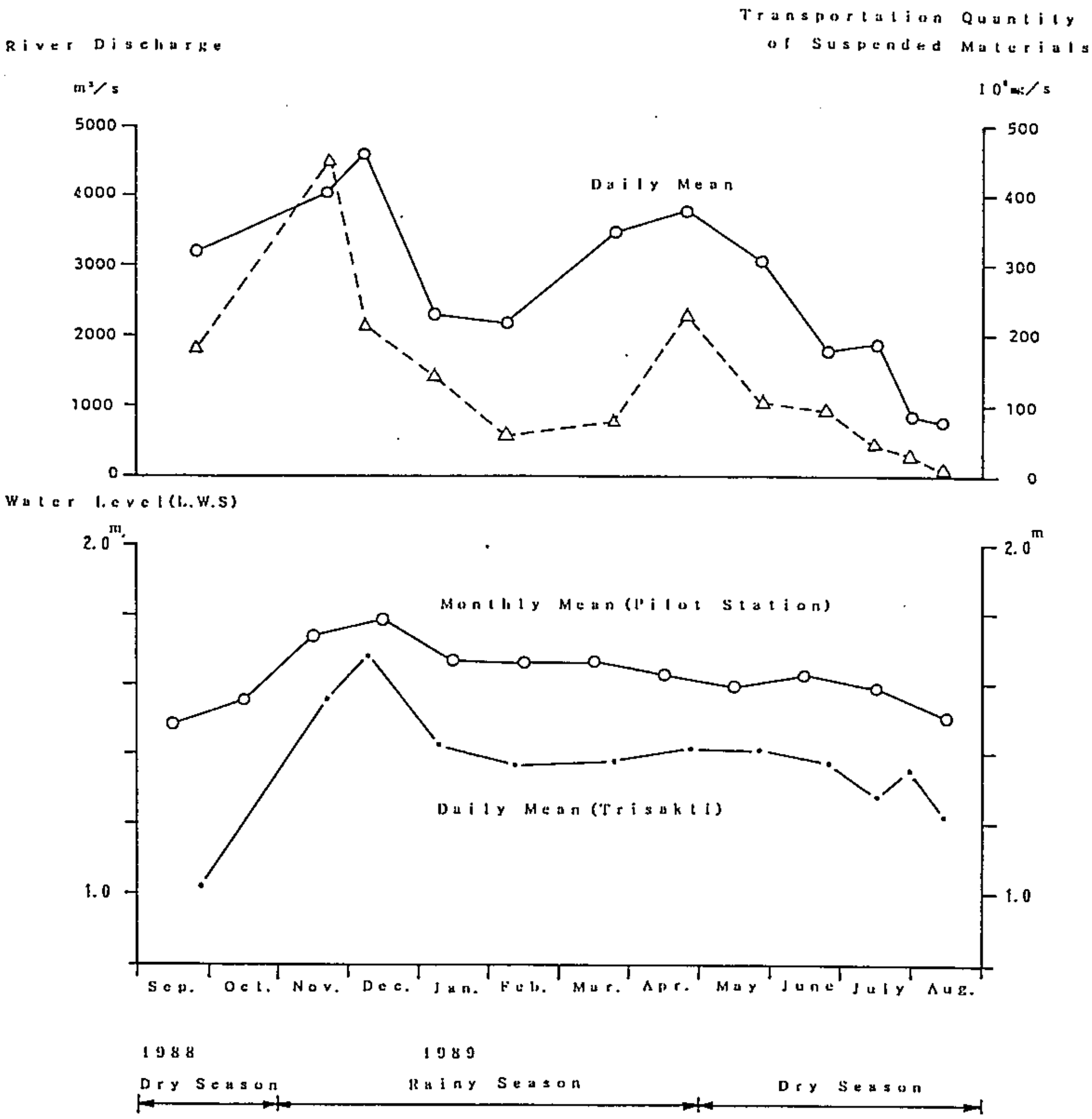


Fig. 5.2.1-2 Variation of Daily Mean River Discharge

3)Transportation Quantity of Suspended Materials

Suspended Materials are tranported with river water from upstream of the Barito River. Variation of Transportation of Quantity of Suspended Materials every month were shown in Fig.5.2.1-2.

According to Fig.5.2.1-2, the transportation quantity showed two peaks as well as river discharge volume and first peak appeared in November with 435 x 10^6 mg/s and second peak appeared in April with 228 x 10^6mg/s. Both peaks exsisted in rainny season.
Minimum transportation quantity appeared in August with 6 x 10^6 mg/s.

Examining the time series, variation of the transportation quantity seemed to be related with momthly mean river discharge volume. So both were examined by correlation and were shown in Fig.5.2.1-3.

According to Fig.5.2.1-3, well correlation between the transportation quantity and daily mean river discharge was found.
However, the transportation quantity in November was very big and the occured time advanced from the occured time of maximum of Daily Mean River Discharge Volume.
It was considered that soil, sand and mud with low density which were accumulated on the river bottom of branch or main river of the Barito during dry season were mixed and agitated by strong river current and flowed into the Barito main stream meanwhile, much surface soil on land washed away by rain water and were supplied to the river.
Further,it was estimated that the abovementioned process would be made a reason to concentrate the transportation quantity of suspended materials, consequently.

4) Flow Rate

Water Level and River Discharge Volume and Transportation Quantity of Suspended Materials in time series during the River Discharge Survey(25 hours continous observation)were shown in Fig.5.2.1-4 and the results of calculation were shown in Table 5.2.1-1.

For the purpose of examining each differ for the River Discharge Volume and Transportaion Quantity between seasons, the following seasons were aimed to eaxamine each variation.

* 2nd Stage of River Discharge Survey on 19th November, 1988 in rainny season when suspended materials were in excess.

* 12th Stage of River Discharge Survey on 13th August, 1989 when suspenceded materials showed at least.

And followings are described about differences between seasons.

(1) Rainy Season (2nd Stage : on 19th November 1988)

River Discharge Volume during River Discharge Survey showed a tendency of flow-out except around the time zone of flood tide and the Daily Mean River Discharge Volume was 4044 m3/s. Maximum of the volume in flow-out appeared at 7 o'clock on 20th November with 8696 m3/s and maximum of volume in flow-in appeared at 1 o'clock on same day with 4379 m3/s. Thus, the volume in flow-in was about a half of it in flow-out. Maximum of the transportation quantity in flow-out appeared at 8 o'clock on 20th November with 1118 x 10^6 mg/s and maximum value in flow-in appeared 1 o'clock on same day with 316 x 10^6 mg/s. This value was one third of it comparing with maximum value of flow-out.
The both occured time for maximum volumes were almost accorded with the occured time for maximum river discharge volumes.

(2) Dry Season (12th Stage : 13th August 1989)

Variation of River Discharge Volume was accorded with water level.
Daily Mean River Discharge Volume was 731 m3/s and difference between rainy and dry season was seven times.
Maximum of the volume at flow-out appeared 18 o'clock on 13th August with 7551 m3/s and it at flow-in appeared at 4 o'clock on 14 th August with 7293 m3/s and both was almost equivalent.
As for transportation quantity, maximum of it at flow-out appeared 19 o'clock on 13th August with 151×10^{6} mg/s and maximum of it at flow-in appeared at 3 o'clock on 14th August with 180×10^{6} mg/s. Muximum of the quantity at flow-in excessed about 10 % comparing with muximum quantity at flow-out.

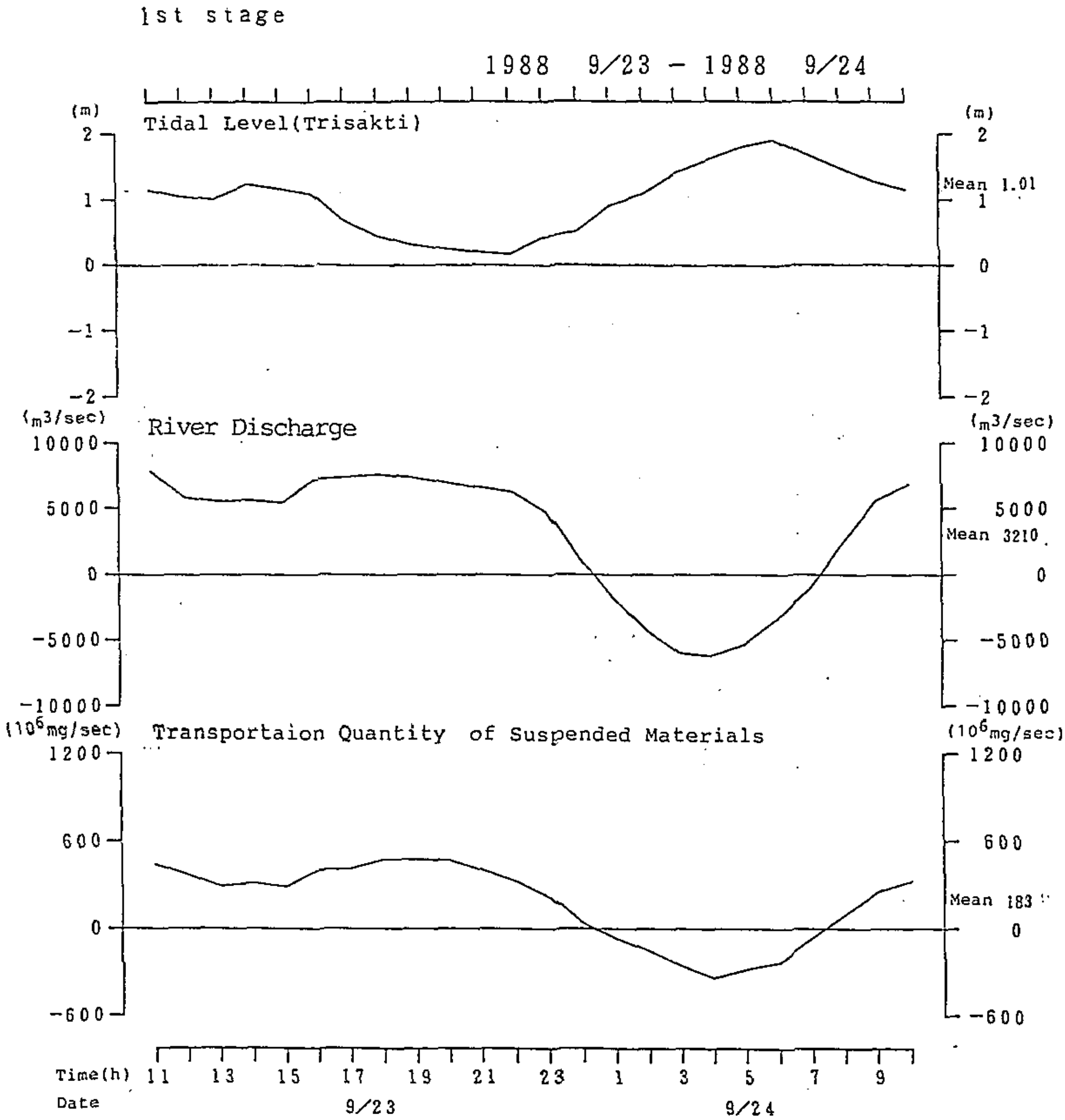


Fig. 5.2.1-4 (1) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

2nd stage

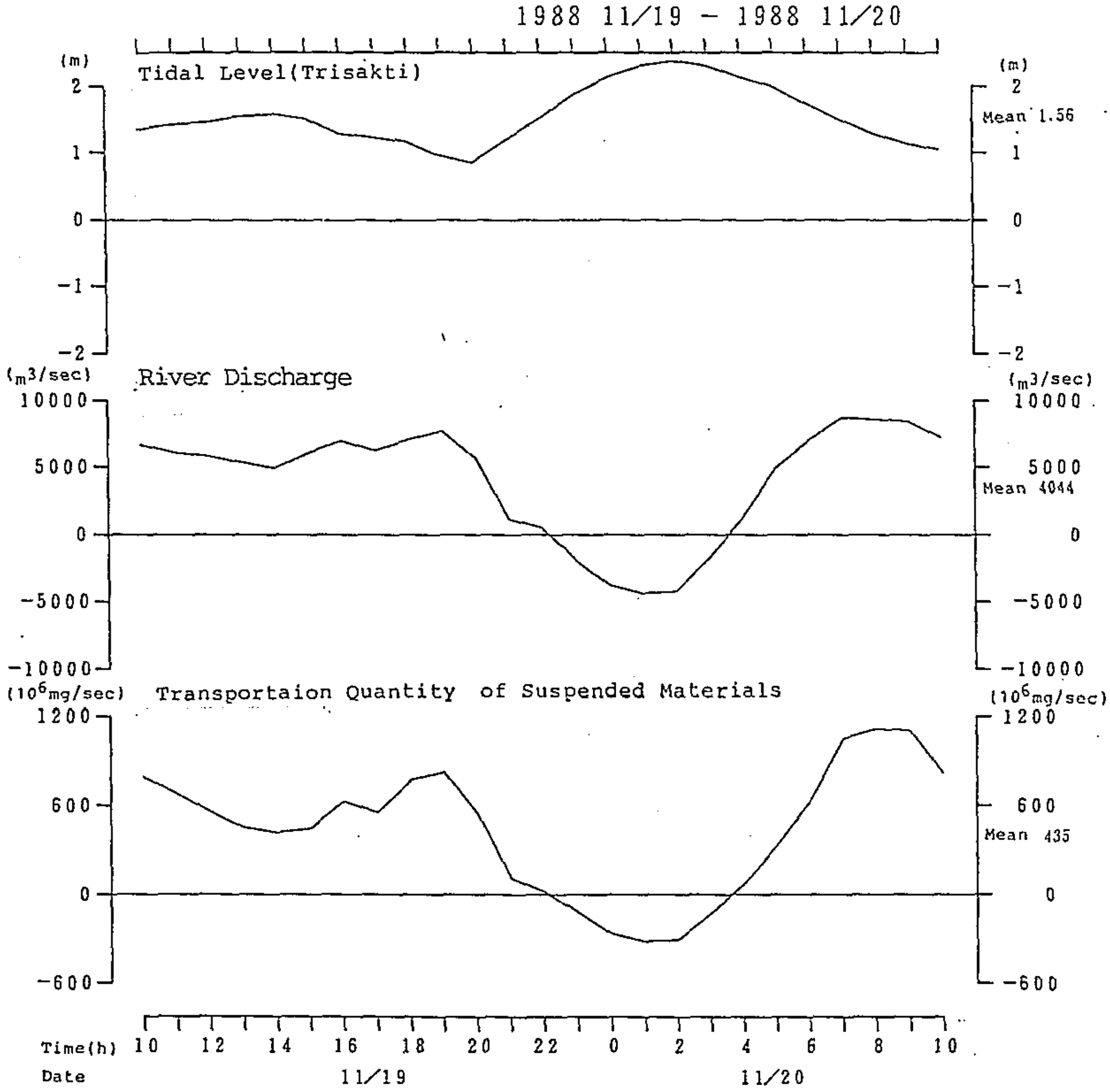


Fig. 5.2.1-4 (2) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

3rd stage

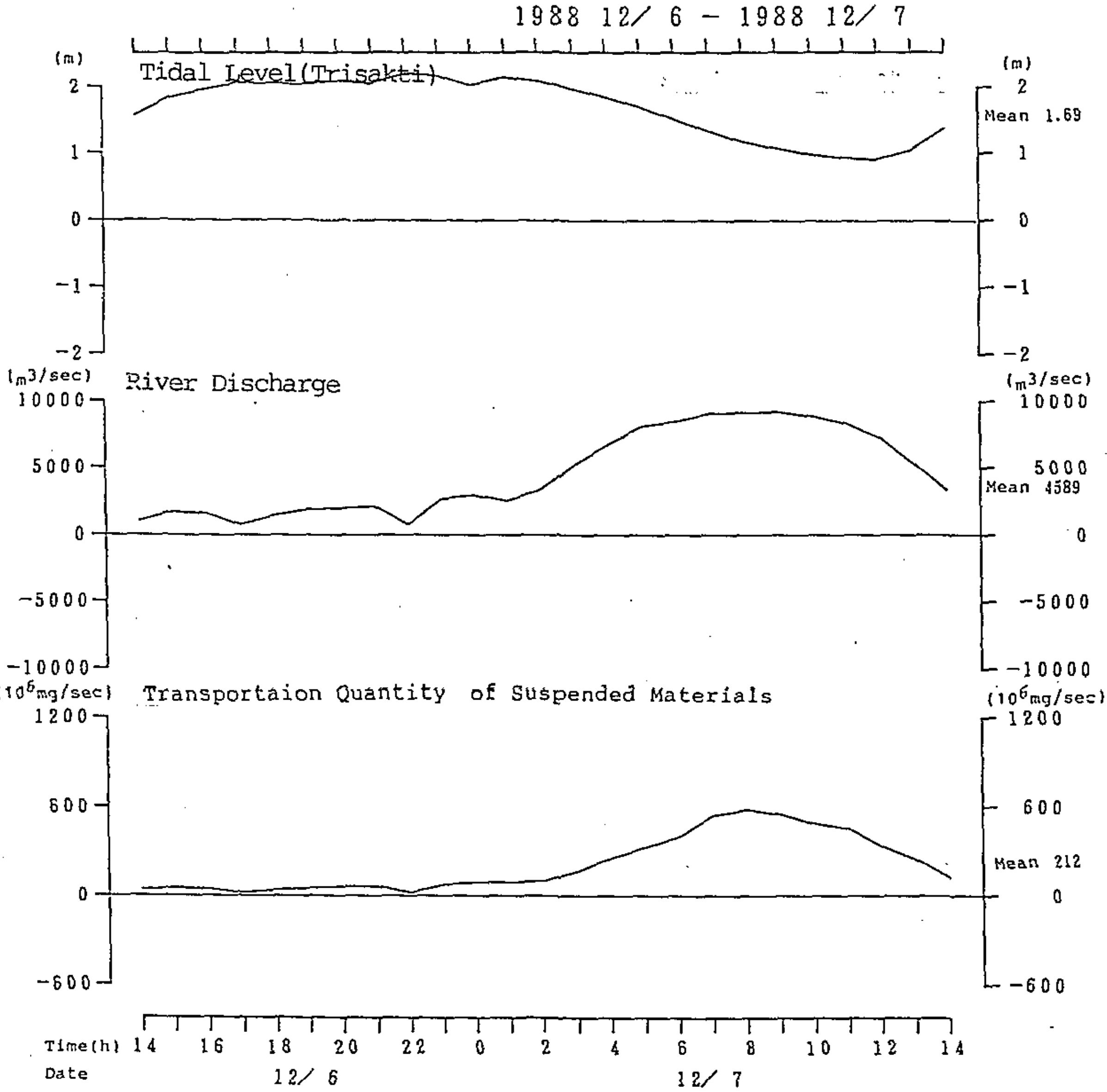


Fig. 5.2.1-4 (3) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

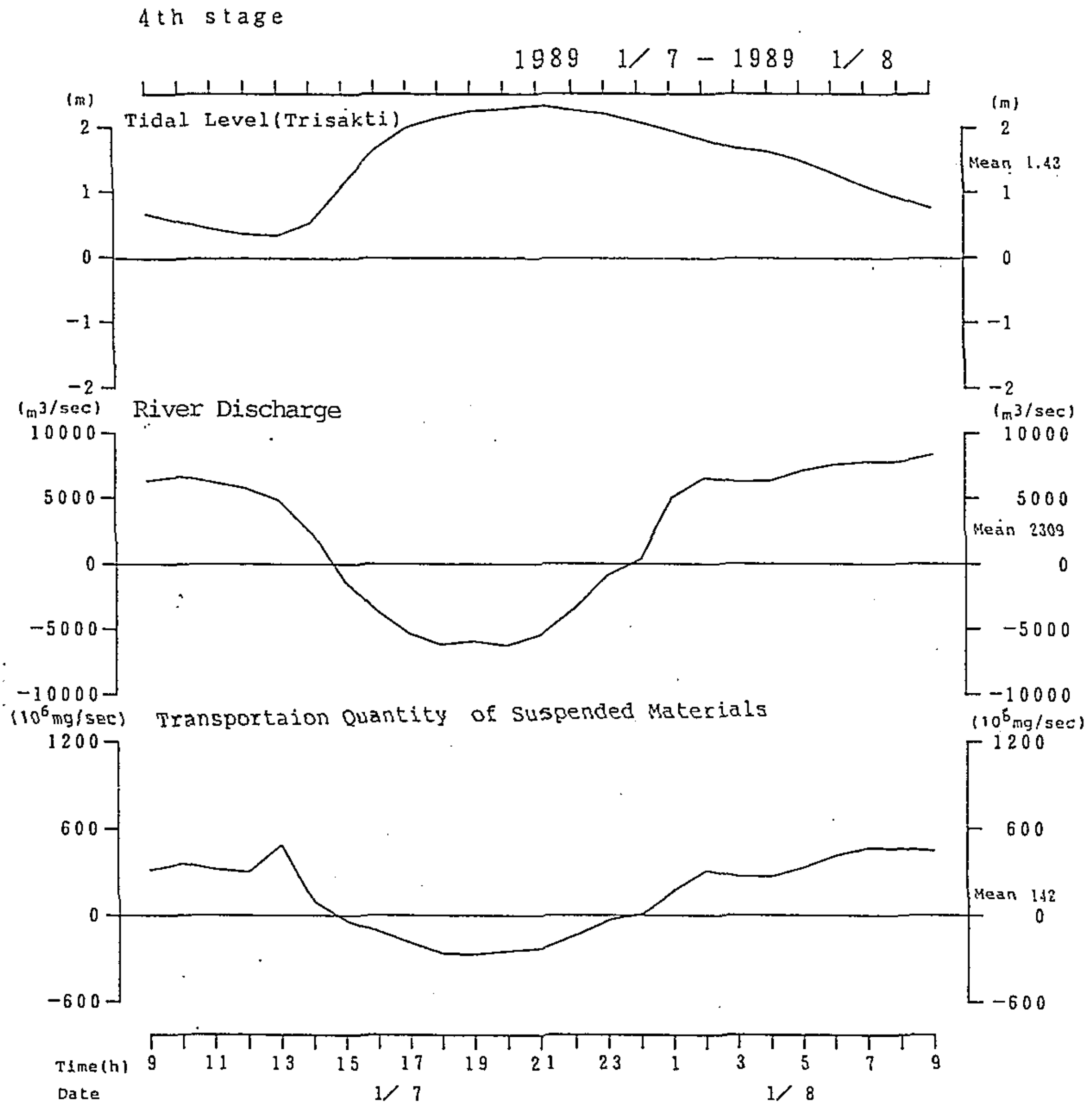


Fig. 5.2.1-4 (4) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

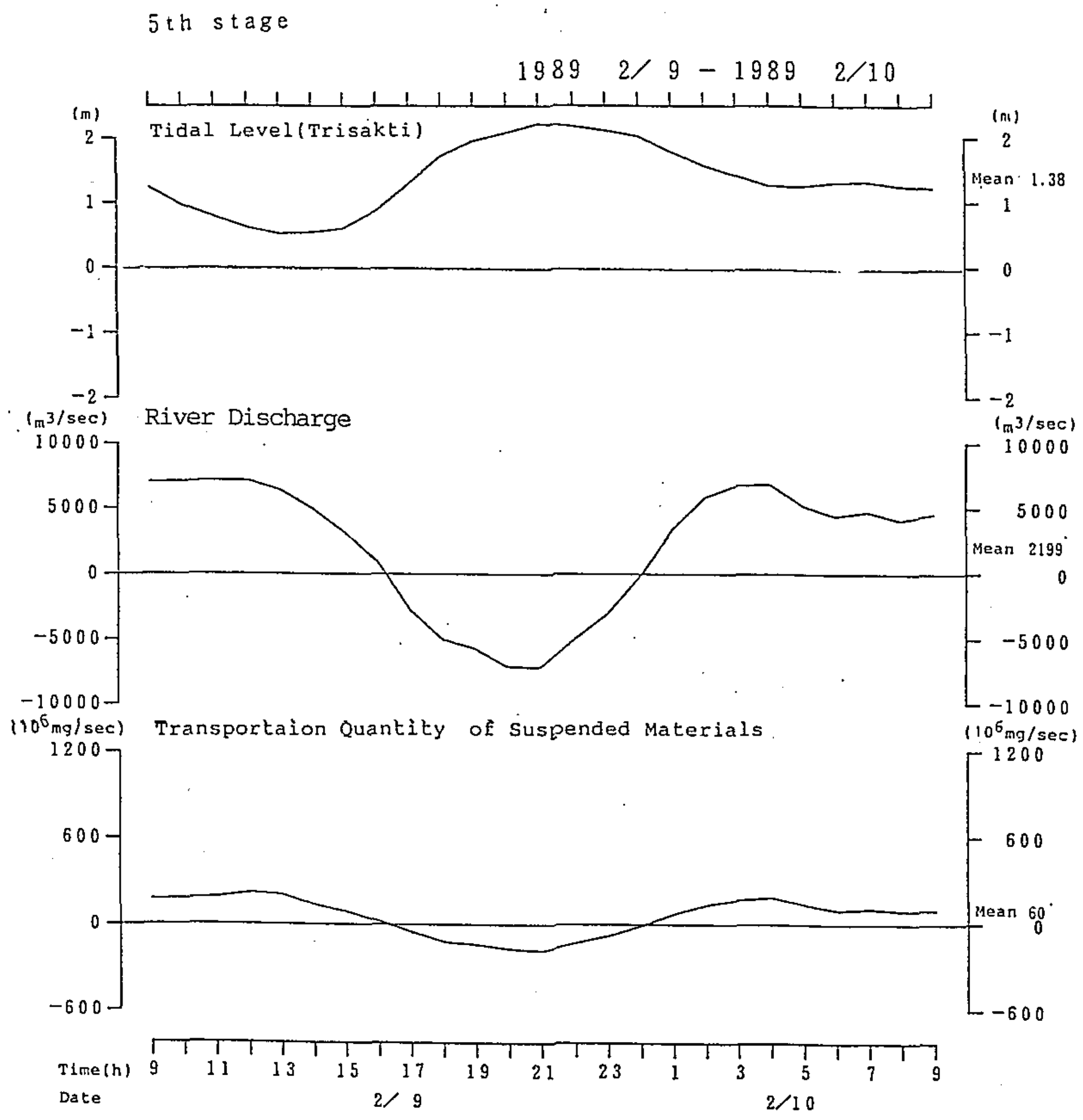


Fig. 5.2.1-4 (5) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

6th stage

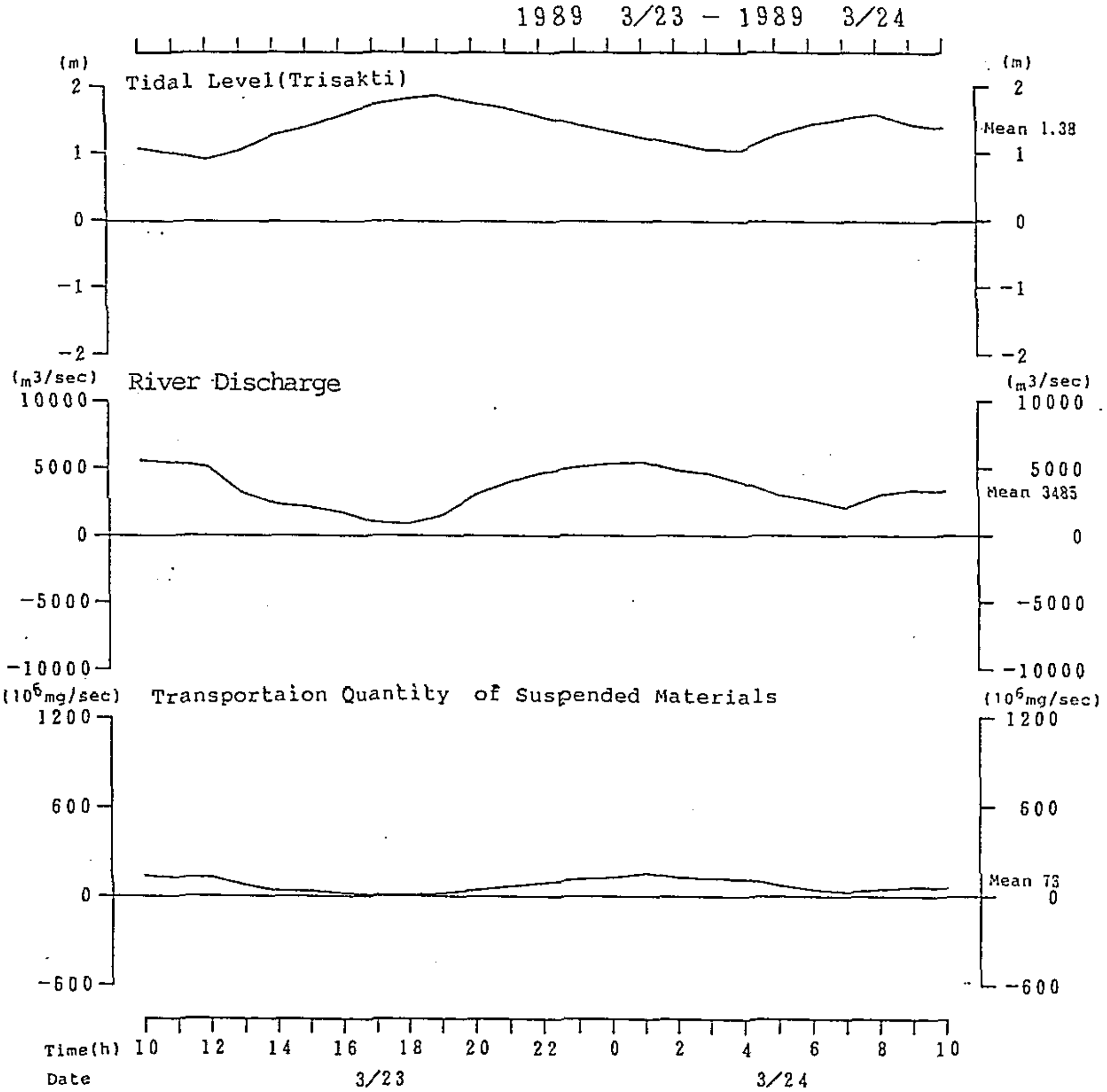


Fig. 5.2.1-4 .(6) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

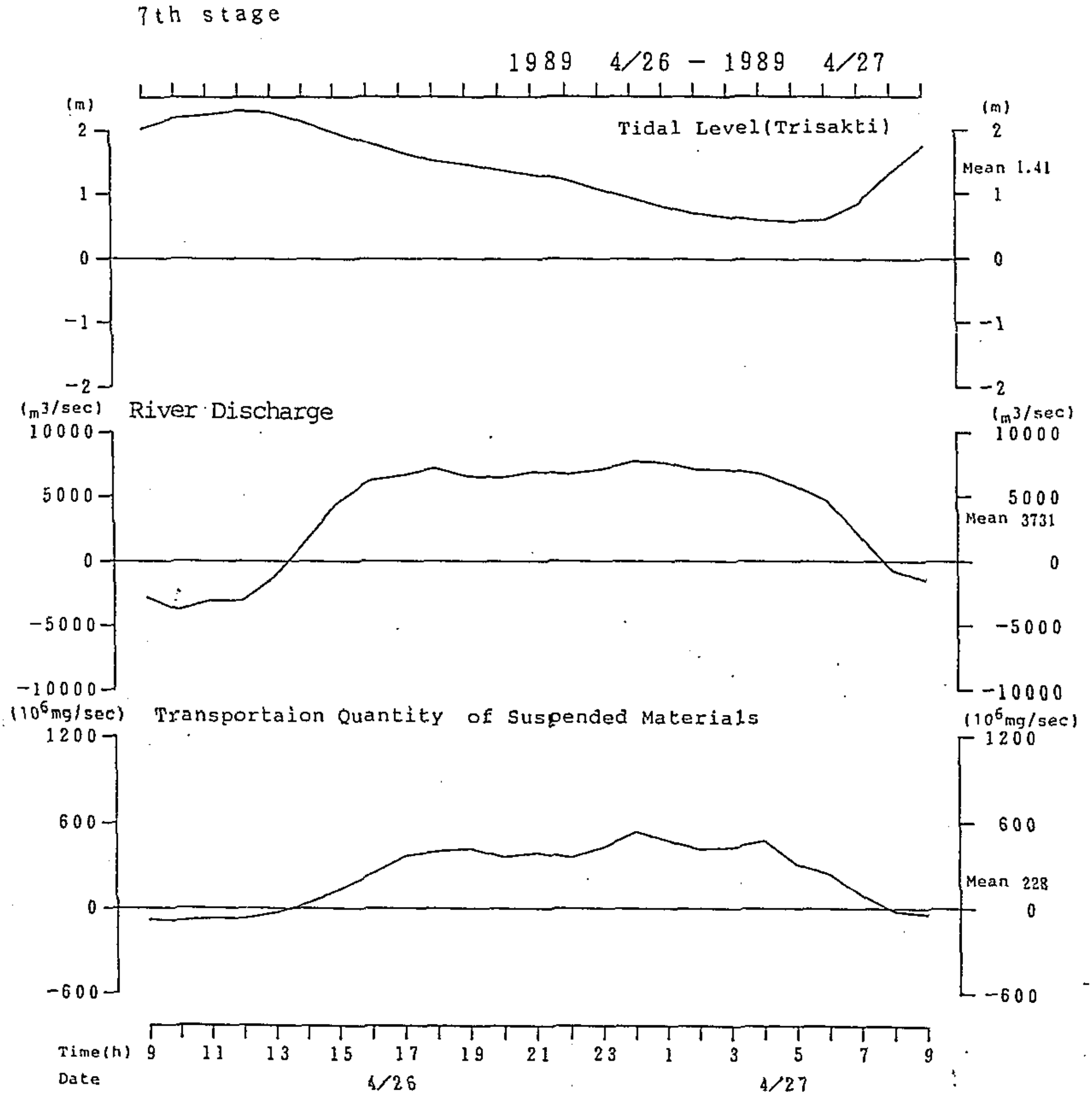


Fig. 5.2.1-4 (7) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

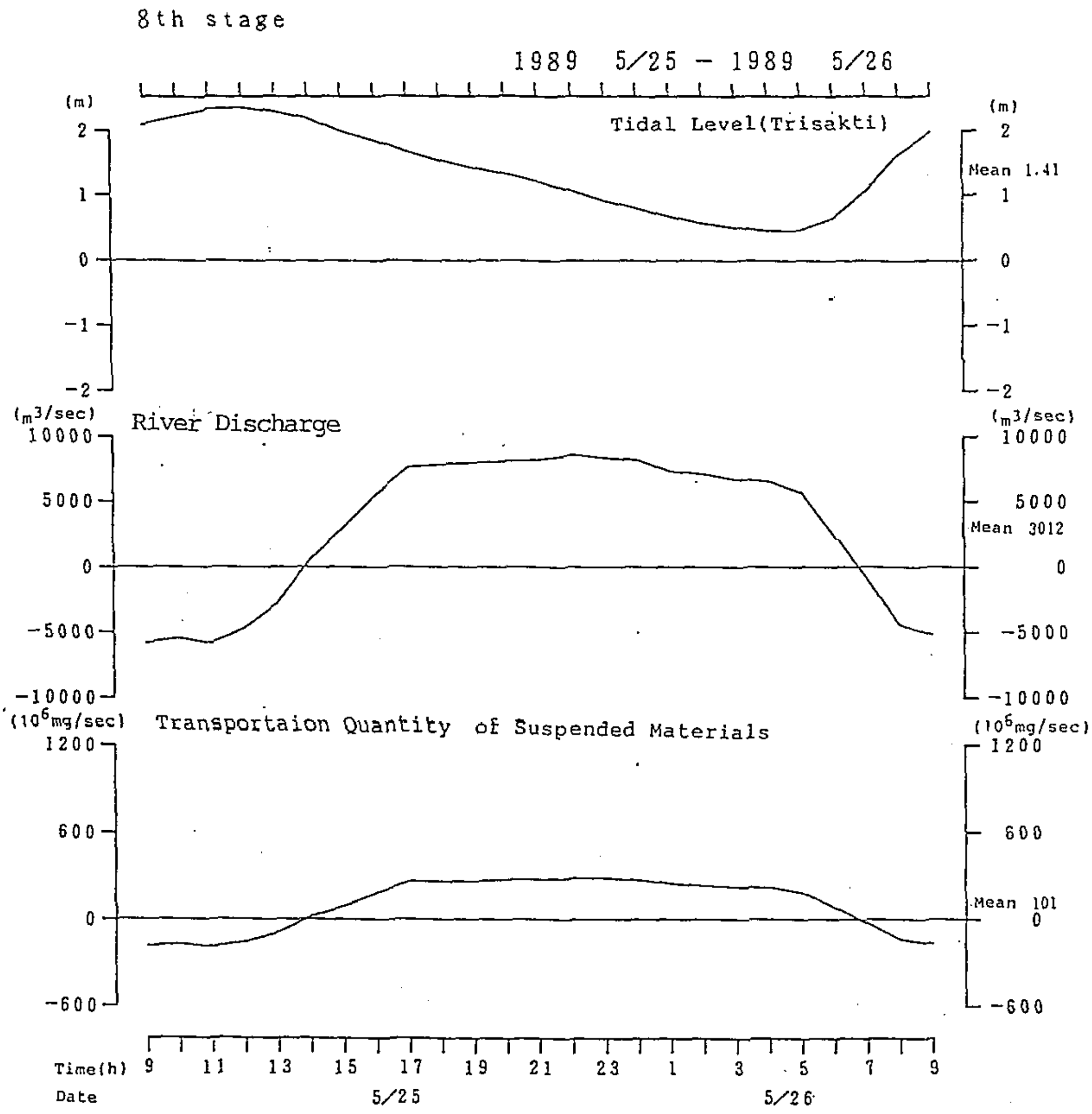


Fig. 5.2.1-4 (8) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

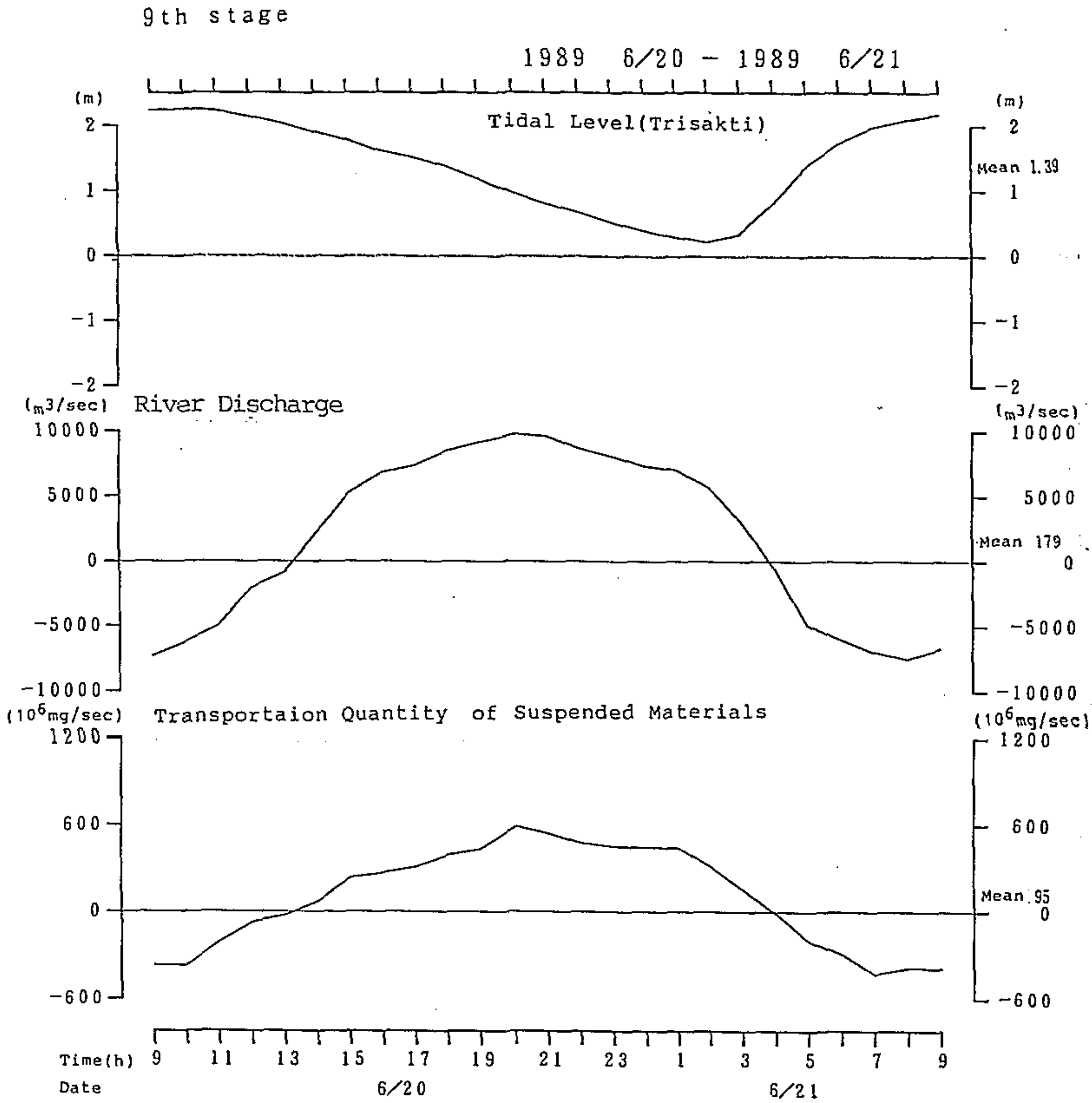


Fig. 5.2.1-4 (9) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

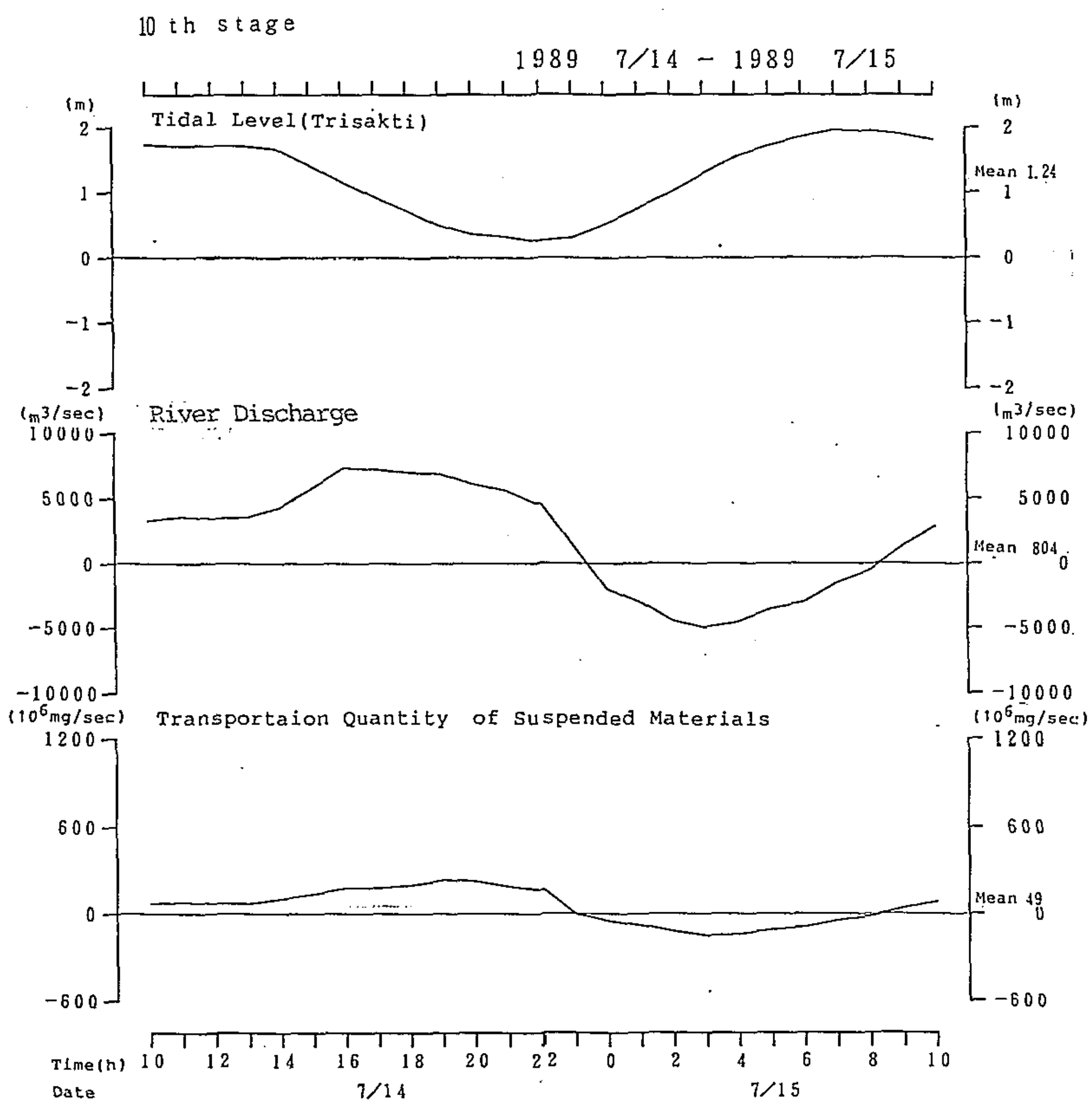


Fig. 5.2.1-4 (10) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

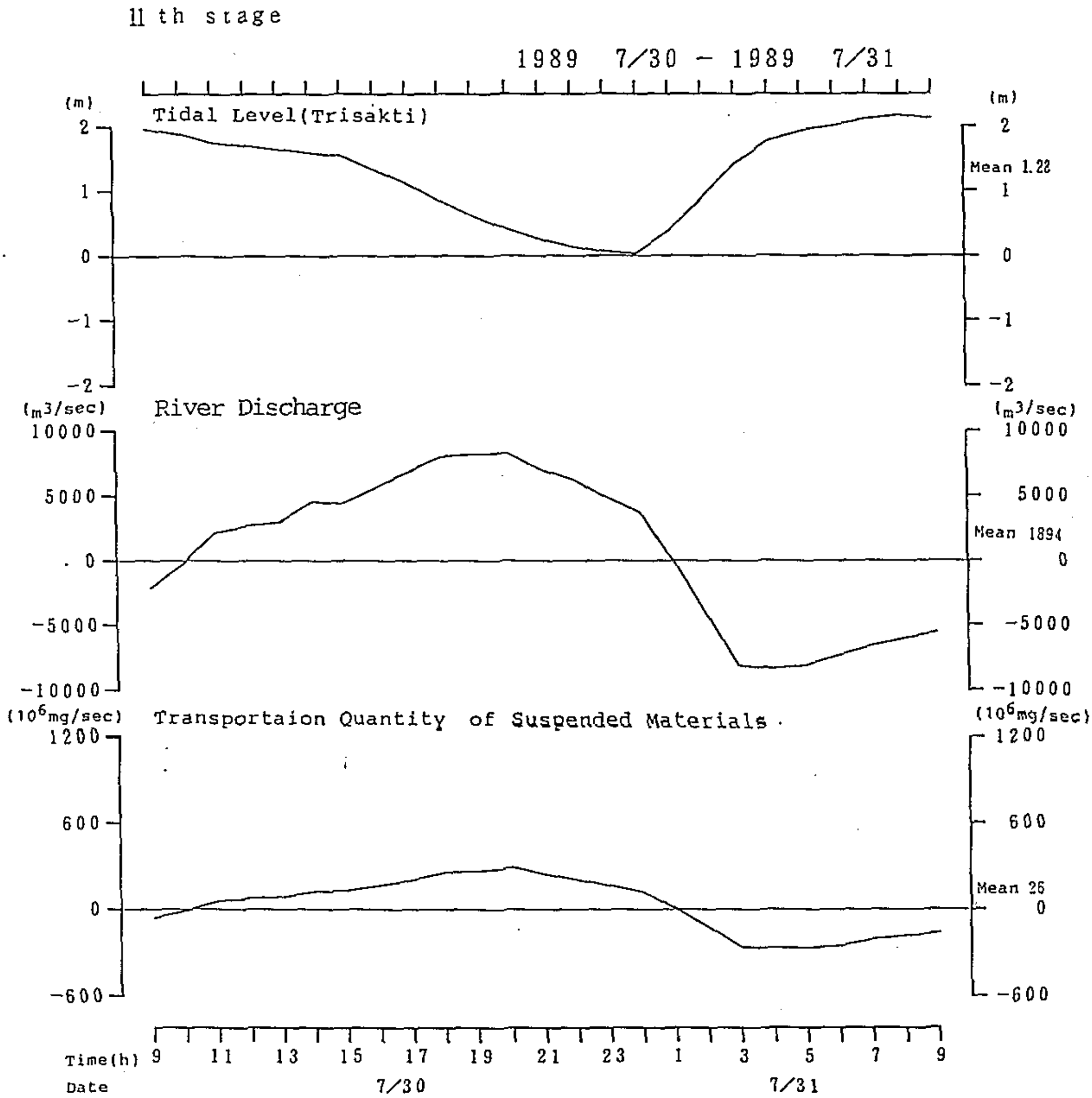


Fig. 5.2.1-4 (11) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

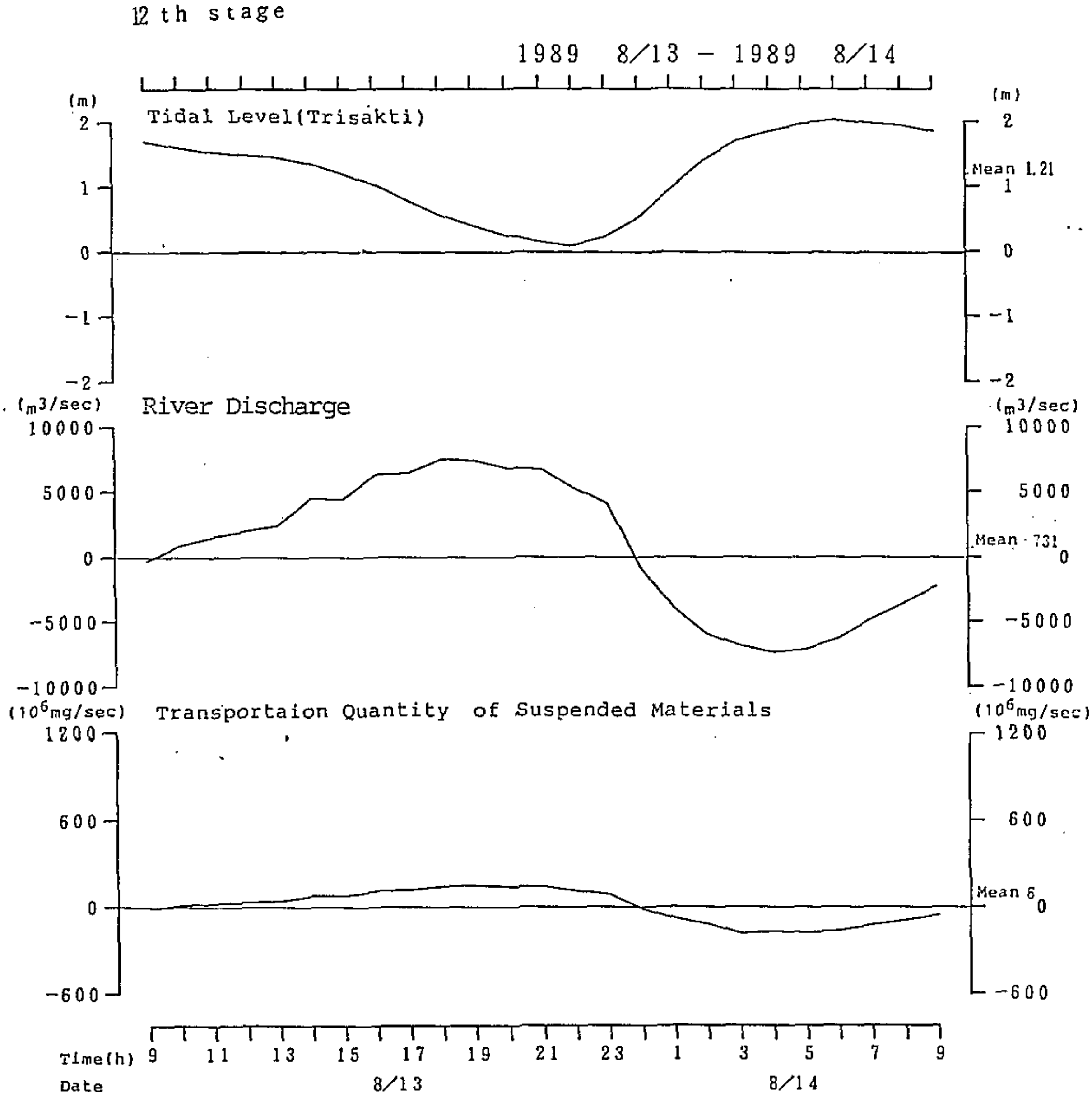


Fig. 5.2.1-4 (12) Time Serial Variation of Tidal Level, Discharge and Transportaion Quantity of Suspended Materials

Table 5.2.1 -1(1) Discharge and Transportation Quantity of Suspended Materials

No.	1988/ 9/23 ~ 9/24 (1st)				1988/11/19 ~ 11/20 (2nd)				1988/12/ 6 ~ 12/ 7 (3rd)			
	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)
1	11	1.16	7936	441	10	1.35	6722	799	14	1.57	1064	40
2	12	1.06	5845	369	11	1.42	6106	682	15	1.84	1711	54
3	13	1.02	5578	294	12	1.46	5835	563	16	1.96	1618	48
4	14	1.25	5643	311	13	1.54	5370	453	17	2.07	779	23
5	15	1.18	5510	290	14	1.57	4962	419	18	2.06	1442	40
6	16	1.11	7222	400	15	1.51	6064	449	19	2.05	1941	57
7	17	0.70	7451	411	16	1.29	7009	634	20	2.09	2017	64
8	18	0.45	7654	476	17	1.23	6297	558	21	2.05	2145	66
9	19	0.32	7448	475	18	1.17	7122	779	22	2.20	804	22
10	20	0.26	7004	471	19	0.96	7776	832	23	2.18	2660	81
11	21	0.21	6632	404	20	0.85	5758	550	0	2.03	3024	95
12	22	0.18	6294	329	21	1.20	1212	113	1	2.15	2583	93
13	23	0.42	4815	223	22	1.51	585	21	2	2.09	3375	104
14	0	0.52	1202	35	23	1.87	-1854	-120	3	1.98	5280	172
15	1	0.92	-1713	-64	0	2.12	-3778	-265	4	1.85	6838	257
16	2	1.10	-4208	-148	1	2.30	-4379	-316	5	1.70	8136	333
17	3	1.40	-5937	-259	2	2.39	-4180	-308	6	1.52	8481	406
18	4	1.60	-6169	-337	3	2.31	-1717	-122	7	1.34	9113	541
19	5	1.80	-5297	-275	4	2.15	1223	76	8	1.18	9149	585
20	6	1.91	-3347	-231	5	2.00	4913	333	9	1.08	9192	553
21	7	1.70	-1075	-62	6	1.74	6991	627	10	0.98	8892	490
22	8	1.50	2362	98	7	1.51	8696	1052	11	0.93	8358	455
23	9	1.30	5601	255	8	1.30	8622	1118	12	0.91	7330	338
24	10	1.17	6941	328	9	1.15	8472	1111	13	1.04	5396	245
25	11	1.07	6868	347	10	1.05	7277	825	14	1.38	3396	129
Mean		1.01	3210	183		1.56	4044	435		1.69	4589	212

Table 5.2.1 -1(2) Discharge and Transportation Quantity of Suspended Materials

No.	1989/ 1/ 7 ~ 1/ 8 (4ht)				1989/ 2/ 9 ~ 2/10 (5th)				1989/ 3/23 ~ 3/24 (6th)			
	Time (h)	Tidal Level (m)	Discharge (m³/sec)	Transp. Q'ty of Suspended Materials (10⁶mg/sec)	Time (h)	Tidal Level (m)	Discharge (m³/sec)	Transp. Q'ty of Suspended Materials (10⁶mg/sec)	Time (h)	Tidal Level (m)	Discharge (m³/sec)	Transp. Q'ty of Suspended Materials (10⁶mg/sec)
1	9	0.66	6382	318	9	1.24	7083	177	10	1.08	5577	138
2	10	0.55	6687	359	10	0.97	7152	179	11	1.00	5450	127
3	11	0.44	6306	324	11	0.79	7177	192	12	0.91	5095	128
4	12	0.36	5810	305	12	0.62	7185	217	13	1.04	3178	76
5	13	0.33	4881	490	13	0.53	6462	202	14	1.27	2295	37
6	14	0.53	2391	97	14	0.55	5006	136	15	1.39	2121	39
7	15	1.11	-1285	-38	15	0.61	3224	88	16	1.55	1736	25
8	16	1.65	-3621	-116	16	0.89	937	21	17	1.72	986	16
9	17	2.00	-5306	-191	17	1.31	-2776	-54	18	1.81	907	14
10	18	2.15	-6164	-264	18	1.73	-4923	-119	19	1.87	1445	23
11	19	2.25	-5888	-268	19	1.97	-5645	-140	20	1.75	2967	47
12	20	2.28	-6191	-243	20	2.09	-7057	-167	21	1.68	3963	73
13	21	2.33	-5417	-225	21	2.23	-7089	-180	22	1.55	4681	97
14	22	2.26	-3401	-135	22	2.19	-4955	-126	23	1.43	5135	116
15	23	2.21	-852	-29	23	2.12	-3089	-76	0	1.33	5383	129
16	0	2.09	364	13	0	2.04	-118	-5	1	1.23	5488	156
17	1	1.96	5064	175	1	1.81	3404	81	2	1.15	4918	127
18	2	1.83	6593	312	2	1.59	5904	144	3	1.05	4633	122
19	3	1.68	6290	270	3	1.44	6870	175	4	1.04	3943	118
20	4	1.63	6348	273	4	1.28	6911	188	5	1.27	3002	77
21	5	1.49	7115	331	5	1.27	5275	143	6	1.42	2580	46
22	6	1.30	7606	414	6	1.33	4466	102	7	1.51	2058	31
23	7	1.10	7841	464	7	1.34	4776	116	8	1.58	3000	52
24	8	0.92	7839	461	8	1.28	4184	98	9	1.44	3351	64
25	9	0.76	8325	447	9	1.25	4624	105	10	1.37	3244	62
Mean		1.43	2309	142		1.38	2199	60		1.38	3485	78

Table 5.2.1 -1(3) Discharge and Transportation Quantity of Suspended Materials

No.	1989/ 4/26 ~ 4/27 (7th)				1989/ 5/25 ~ 5/26 (8th)				1989/ 6/20 ~ 6/21 (9th)			
	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)
1	9	2.03	-2774	-80	9	2.09	-5802	-187	9	2.24	-7247	-372
2	10	2.19	-3758	-92	10	2.21	-5406	-172	10	2.26	-6193	-374
3	11	2.24	-3033	-73	11	2.32	-5768	-191	11	2.24	-4926	-206
4	12	2.30	-3015	-70	12	2.35	-4691	-157	12	2.14	-2030	-73
5	13	2.28	-1237	-27	13	2.28	-2755	-88	13	2.04	-846	-23
6	14	2.14	1573	43	14	2.19	631	22	14	1.90	2134	75
7	15	1.98	4406	133	15	2.00	2883	94	15	1.78	5297	235
8	16	1.81	6227	240	16	1.85	5611	183	16	1.62	6811	268
9	17	1.65	6672	368	17	1.67	7625	260	17	1.52	7323	315
10	18	1.52	7236	398	18	1.53	7819	262	18	1.38	8464	394
11	19	1.47	6612	417	19	1.42	7986	261	19	1.19	9115	432
12	20	1.38	6506	359	20	1.33	8065	275	20	0.98	9790	588
13	21	1.31	6982	387	21	1.22	8163	273	21	0.81	9606	543
14	22	1.22	6784	356	22	1.07	8595	286	22	0.67	8646	474
15	23	1.08	7132	428	23	0.91	8358	284	23	0.53	8086	453
16	0	0.94	7788	539	0	0.80	8174	271	0	0.40	7322	449
17	1	0.80	7660	476	1	0.67	7361	248	1	0.29	7089	444
18	2	0.70	7113	412	2	0.57	7156	235	2	0.22	5681	317
19	3	0.64	7147	427	3	0.50	6779	222	3	0.34	3163	155
20	4	0.59	6835	477	4	0.45	6607	217	4	0.80	-555	-17
21	5	0.57	5844	308	5	0.45	5777	186	5	1.36	-4863	-202
22	6	0.60	4772	241	6	0.64	2504	78	6	1.73	-5968	-293
23	7	0.84	1965	94	7	1.05	-861	-27	7	1.97	-6934	-429
24	8	1.33	-707	-19	8	1.61	-4374	-140	8	2.09	-7475	-388
25	9	1.74	-1456	-38	9	1.98	-5145	-166	9	2.18	-6668	-390
Mean		1.41	3731	228		1.41	3012	101		1.39	1793	95

Table 5.2.1 -1(4) Discharge and Transportation Quantity of Suspended Materials

No.	1989/ 7/14 ~ 7/15 (10th)				1989/ 7/30 ~ 7/31 (11th)				1989/ 8/13 ~ 8/14 (12th)			
	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)	Time (h)	Tidal Level (m)	Discharge (m^3/sec)	Transp. Q'ty of Suspended Materials (10^6mg/sec)
1	10	1.74	3334	70	9	1.97	-2091	-58	9	1.71	-234	-8
2	11	1.72	3638	80	10	1.89	-216	-4	10	1.62	925	17
3	12	1.72	3480	69	11	1.76	2201	63	11	1.54	1585	30
4	13	1.72	3582	71	12	1.71	2762	80	12	1.50	2032	38
5	14	1.68	4336	105	13	1.66	3016	89	13	1.47	2473	46
6	15	1.43	5753	140	14	1.60	4604	127	14	1.37	4560	87
7	16	1.17	7356	182	15	1.55	4483	131	15	1.22	4495	86
8	17	0.94	7214	182	16	1.34	5766	171	16	1.04	6386	120
9	18	0.73	7039	202	17	1.14	6915	208	17	0.80	6485	123
10	19	0.50	6920	235	18	0.88	8004	259	18	0.58	7551	146
11	20	0.37	6140	228	19	0.64	8241	268	19	0.42	7438	151
12	21	0.32	5659	190	20	0.43	8278	296	20	0.26	6853	140
13	22	0.25	4562	164	21	0.27	7005	247	21	0.15	6784	142
14	23	0.30	1289	1	22	0.16	6209	209	22	0.09	5266	112
15	0	0.52	-1917	-49	23	0.08	4905	166	23	0.23	4162	87
16	1	0.75	-2965	-82	0	0.05	3800	122	0	0.53	-771	-14
17	2	0.99	-4427	-127	1	0.41	98	2	1	0.96	-3904	-83
18	3	1.29	-4958	-152	2	0.89	-3979	-125	2	1.40	-5892	-120
19	4	1.55	-4533	-142	3	1.43	-8093	-261	3	1.71	-6784	-180
20	5	1.72	-3525	-112	4	1.77	-8297	-268	4	1.86	-7293	-168
21	6	1.86	-2994	-89	5	1.93	-8089	-269	5	1.98	-7095	-176
22	7	1.96	-1444	-42	6	2.02	-7322	-252	6	2.04	-6257	-163
23	8	1.94	-525	-14	7	2.11	-6588	-207	7	1.99	-4759	-125
24	9	1.90	1442	42	8	2.18	-5995	-184	8	1.95	-3531	-89
25	10	1.82	2885	84	9	2.12	-5524	-162	9	1.86	-2195	-51
Mean		1.24	1894	49		1.28	804	26		1.21	731	6

5.2.2 Saline Wedge

Saline Wedge Surveys were carried out from September 1988 to August 1989 with average one time per a(1) month and total twelve times.

The survey date and time are shown in under table.

Table Date and Time of Saline Wedge Survey

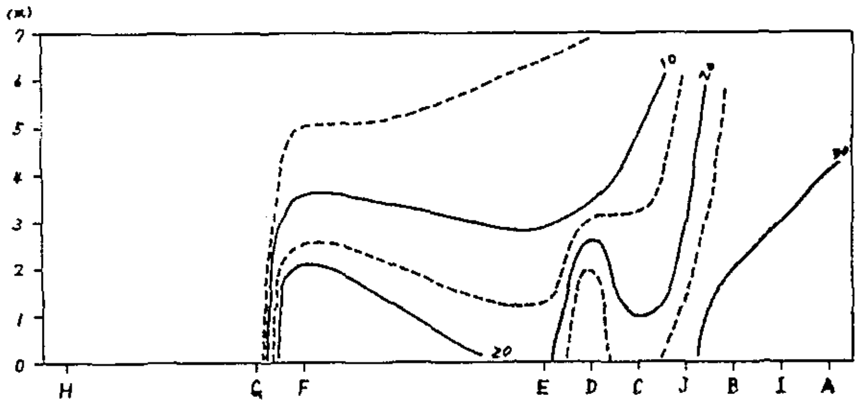
Stage(St.)		Date and time
1st stage(B,D,F,H)	;	11th(10:00)-12th(10:00) Oct. 1988
(A,C,E,G)	;	15th(10:00)-16th(10:00) Oct. 1988
2nd stage(D,F,I,J)	;	11th(10:00)-12th(10:00) Nov. 1988
(A,B,C,E)	;	16th(10:00)-17th(10:00) Nov. 1988
3rd stage(D,F,I,J)	;	10th(11:00)-11th(11:00) Dec. 1988
(A,B,C,E)	;	13th(19:00)-14th(19:00) Dec. 1988
4th stage(D,F,I,J)	;	29th(10:00)-30th(10:00) Dec. 1988
(A,B,C,E)	;	3th(10:00)- 4th(10:00) Jan. 1989
5th stage(D,F,I,J)	;	31th(10:00)Jan.-1th(10:00)Feb.1989
(A,B,C,E)	;	6th(10:00)- 7th(10:00) Feb. 1989
6th stage(D,F,I,J)	;	16th(11:00)-17th(11:00) March 1989
(A,B,C,E)	;	20th(11:00)-21th(11:00) march 1989
7th stage(A,B,C,E)	;	30th(11:00)Apr.-1th(11:00)May 1989
(D,F,I,J)	;	13th(09:00)-14th(09:00) May 1989
8th stage[D,F,I(E),J(E)]	;	7th(11:00)- 8th(11:00) May 1989
[A(E),B(E),C(E),E]	;	11th(11:00)-12th(11:00) June 1989
9th stage[A(E),C(E),E,G]	;	24th(11:00)-25th(11:00) June 1989
[B(E),D,F,H]	;	28th(10:00)-29th(11:00) June 1989
10th stage(A,C,E,G)	;	7th(10:00)- 8th(11:00) July 1989
(B,D,F,H)	;	10th(10:00)-11th(11:00) July 1989
11th stage[A(E),C(E),E,G]	;	22th(10:00)-23th(11:00) July 1989
[B(E),D,F,H]	;	26th(10:00)-27th(11:00) July 1989
12th stage(A,C,E,G)	;	6th(10:00)- 7th(10:00) Aug. 1989
(B,D,F,H)	;	10th(10:00)-11th(11:00) Aug. 1989

For the purpose of grasping the distribution structure of salinity in the Barito river, distributions in profile of daily mean salinity, turbidity and current velocity which was projected to stream axis of the river in rainy and dry season were shown in Fig.5.2.2-1.

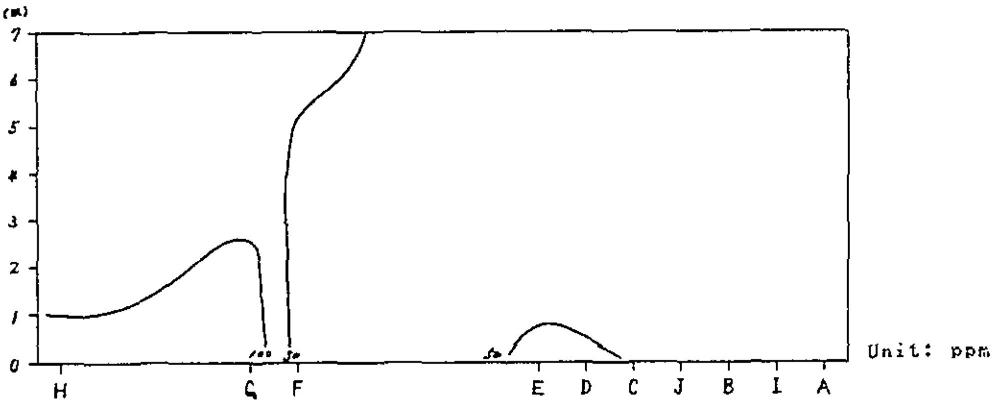
Examinig distribution of salinity in dry season, front of salinity in a level of 20 (salinity unit: non dimension) reached to around St.G near Trisakti and structure of saline wedge from St.C in the mouth of river to St.G showed a weak mixed type. A layer which salinity concentration changes suddenly exists about 3 m above seabed. Contrasting the salinity and current velocity, current containing high salinity with a level of 20 showed tendency of flow-in at lower layer and river water at surface layer showed tendency of flow-out.

In the rainy season, front of sea water with a level of 20 pushed out to the offing end of the Access Channel due to the increased river water discharge volume and saline wedge in the Access Channel showed distribution of strong mixed type. River water in company with great regression of sea water reached to the offing end of the Access Channel and distribution of current velocity showed tendency of strong mixed type.

Daily Mean Salinity



Daily Mean Turbidity



Daily Mean Velocity of Principal River Axis

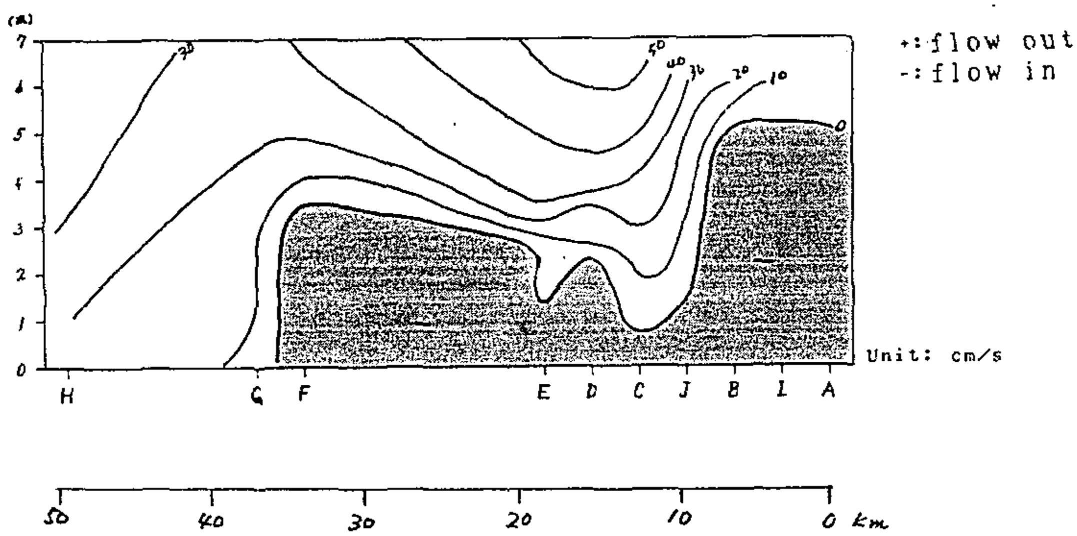


Fig. 5.2.2 — 1(1) Longitudinal Section of Salinity, Turbidity and Velocity (Daily Mean) in Dry Season (10th and 15th Oct. 1988)

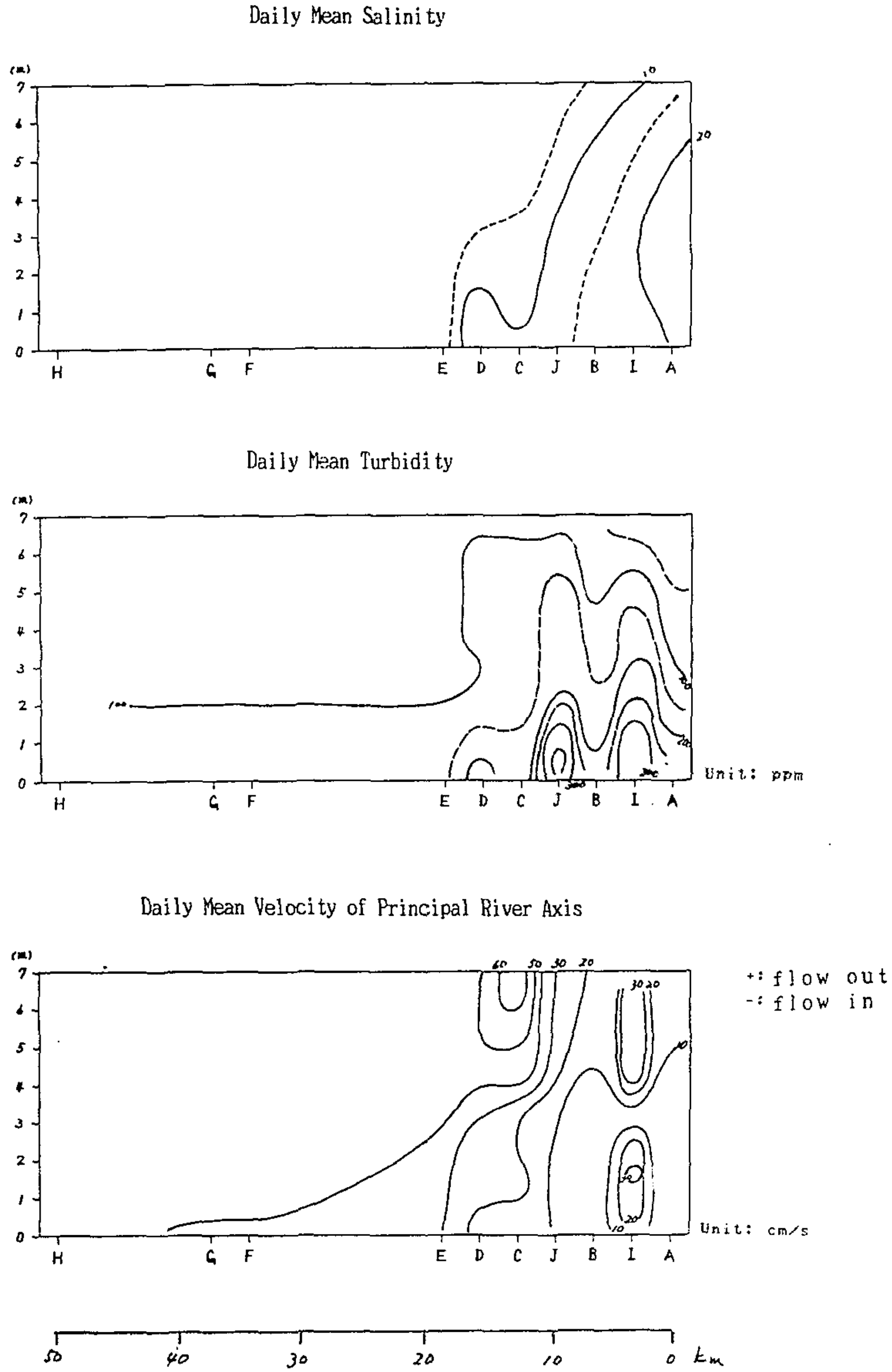


Fig. 5.2.2 − 1(2) Longitudinal Section of Salinity, Turbidity and Velocity (Daily Mean) in Rainy Season (10th and 13th Dec. 1988)

5.2.3 Bottom Materials

A point of view from the bottom materials in whole stations, silt and clay are a large in the muddy sediments and are dominant through all survey stages.
Water content shows in the range of between 120 and 160% at many survey stations, but the maximum water content appears in the range of between 201% and 274% through all stages. (cf.Table 5.2.3-1)
The grain size distributions of the bottom materials in the survey area are undermentioned in the three divided areas. (cf.Fig.5.2.3-3(1)-(3))

1) River area(st.G and St.H)

As for St.G, sand contents in the 1st and 10th stage show each 98%. That of in the 11th and 12th stage show in the range of between 81 and 82%. That of in the 9th stage shows only 12%.
As the mentioned above, sand contents at st.G are dominant except the 9th stage.
In case of St.H, sand content shows 25 % in the 1st, 23% in the 10th and 47% shows in the 9th and 11th stage, respectively.
Thus, sand content at St.H varies within the range between 15% and 50%.

2) Middle area(St.F and F1 - F5)

As for St.F,sand content in the 1st and 2nd shows 55% and 62%, respectively. That of the 3rd to 7th stage shows a lttle in the range of between 5 - 15%.
That of through the 8th to 12th stage shows comperative large value with 98% of the 8th and 82% of the 12th stage.
As for F1 - F5, sand contents through all stages shows generally in the range of between 5 - 20% except F4 and exceeding 90% in F2 at the time of 9th to 12th stage.
As for St.F4,the appeared sand content in the range of 20 to 50% shows in two times.
As for other staions, sand contents show always in the range 90 to 100% and it is found that this area is to be stable sand area.

3) Estuary area(St.E,D and C)

As for St.E in the upstream area of the estuary, sand contents show a little between 5% and 15% at each stage except the cases of content 82% at the 9th stage and 86% at the 11th. It suggests that this area is apt to suffer by the transportation of the river.
In the estuary area including St.C and D, sand contents 70% in the 2nd and 86% in the 9th stage at St.D. But sand contents in other stages are a little and it's range between about 10 to 45% with silt contents more than 45%.

4) Access channel area(St.J,B,I and A)

This area is clay and silt area and sand contents is a few in this area.Sand contents in St.D is a little between 15% and 40% but the almost appeared contents are less than 20%.
As for St.B, sand contents vary in the range of between 10-50% through all stage except that of 86% in the 10th stage.
However, almost of sand contents in this area show in the range of between 10% and 25 % and clay contents are dominant.
Sand content at St.I shows almost less than 25% even maximum shows 28% in the 2nd stage.
At St.A adjacent to an end of the access channel, sand contents never exceed 20 % and show in the range of between 5-18%. It suggests that this area mainly consists of the clay and silt.

5) Correlation among Bottom Materials in Distribution

For the purpose of grasping the characteristic of the bottom materials in distribution, correlation diagrams were made as shown in Fig.5.2.3-4(1)-(5).
Correlation diagrams were comprised in the following seasons and areas.

(a) All Seasons : Fig.5.2.3-4(1)
(b) Dry Season : Fig.5.2.3-4(2)
(c) Rainy Season : Fig.5.2.3-4(3)
(d) River Area : Fig.5.2.3-4(4)
(e) Estuary to Access Channel: Fig.5.2.3-4(5)

According to Fig.5.2.3-4(1) in All Seasons, Correlation between Water Content and Ignition Loss is r=0.75 and is Positive.

Examining the ccorrelation by each season, values of correlation are r=0.70 in dry season and r=0.80 in rainy. Comparing with
both season, the value in rainy season is a little higher than it in dry season.

Correlations between water content and ignition loss as shown in Fig. 5.2.3-4(4) and 5.2.3-4(5) show r=0.78 in river area and r=0.60 in an area from Estuary to Access Channel. The value in an area from Estuary to access Channel become low comparing with it of River area.

Correlations between Ignition Loss and D50 and between Water Content and D-50 were examined but good correlations among them not appeared.

1 st Monthly Survey

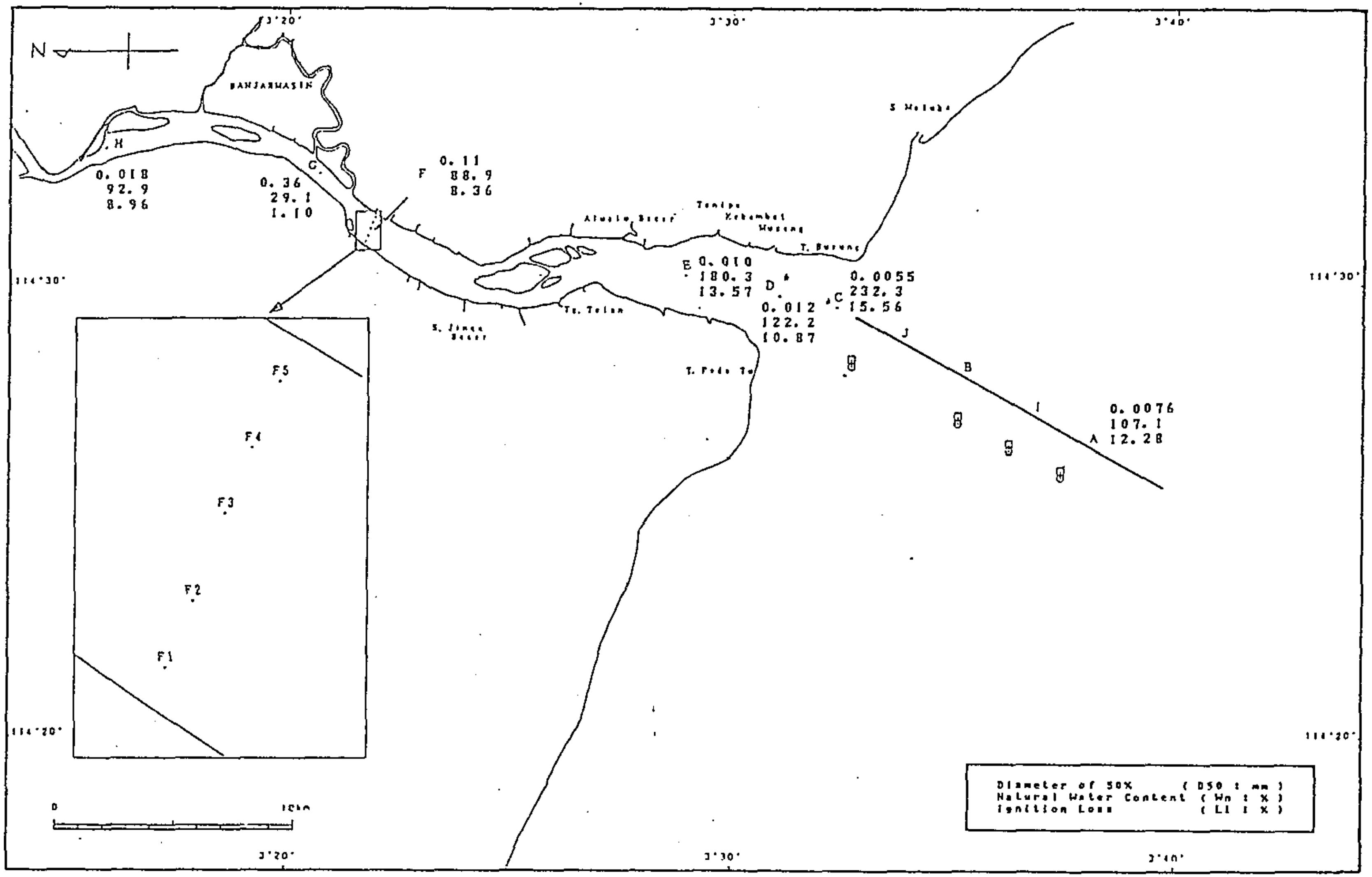


Fig. 5.2.3-1(1) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

2 nd Monthly Survey

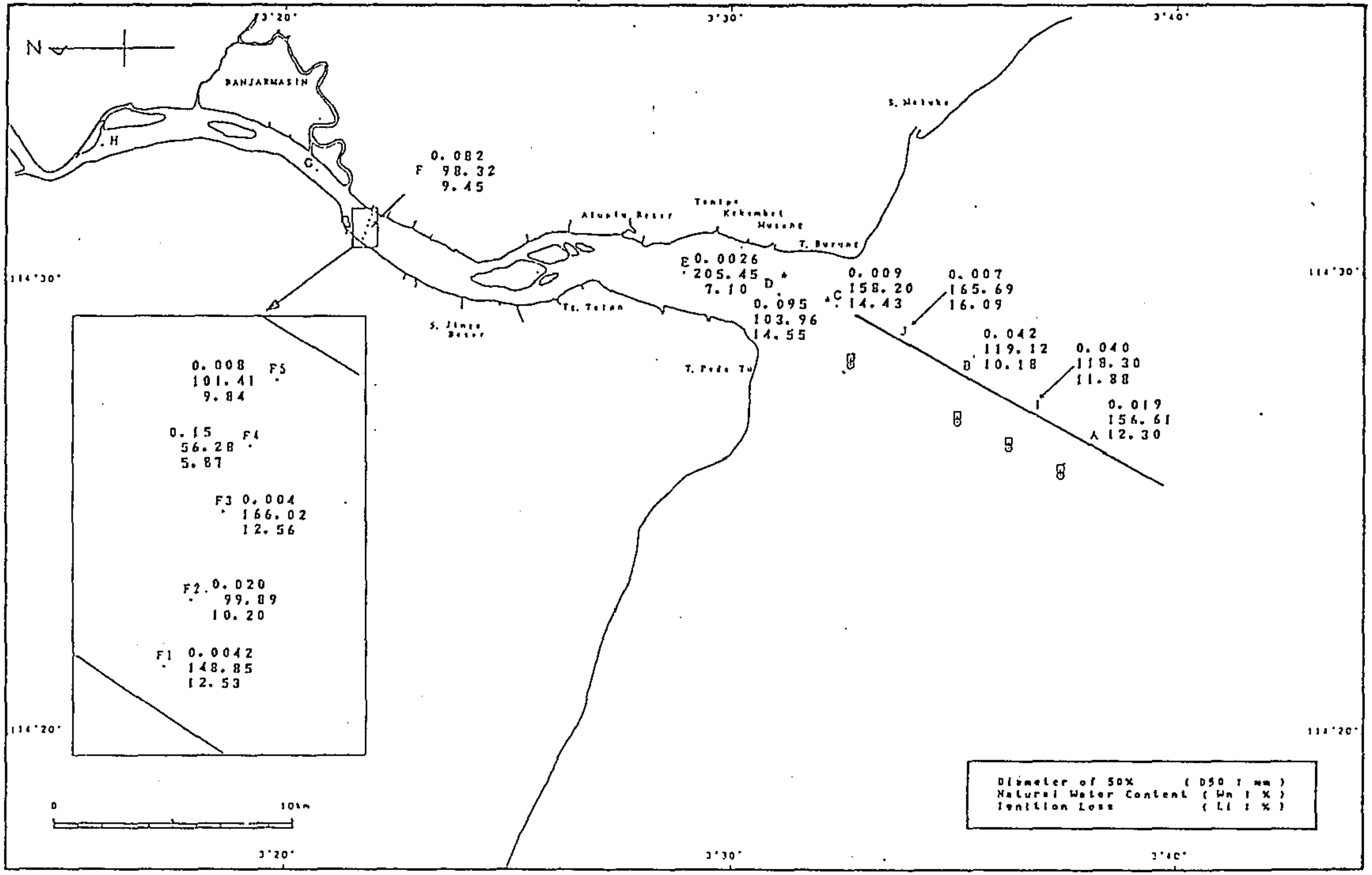


Fig. 5.2.3-1(2) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

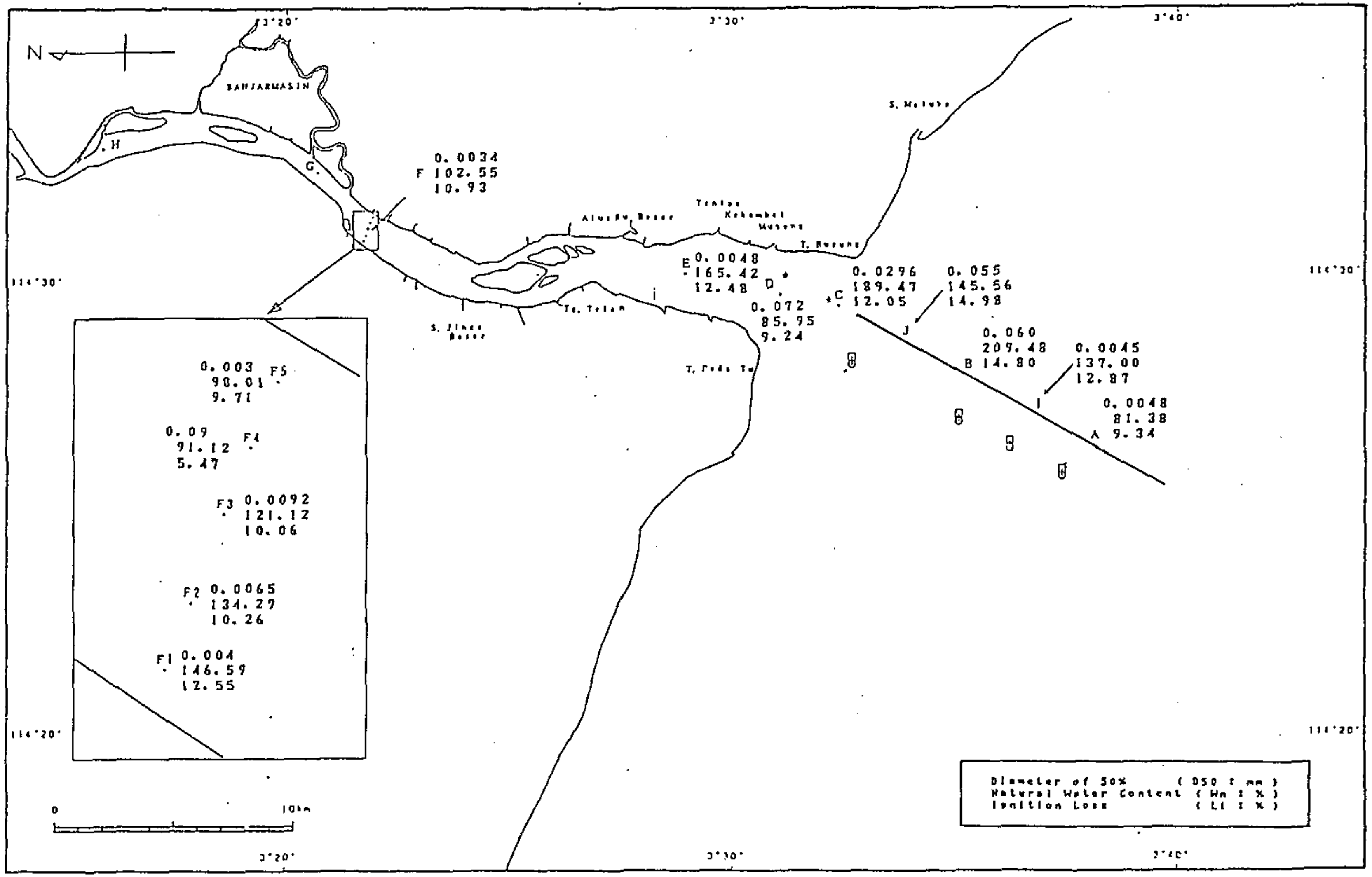


Fig. 5.2.3-1(3) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

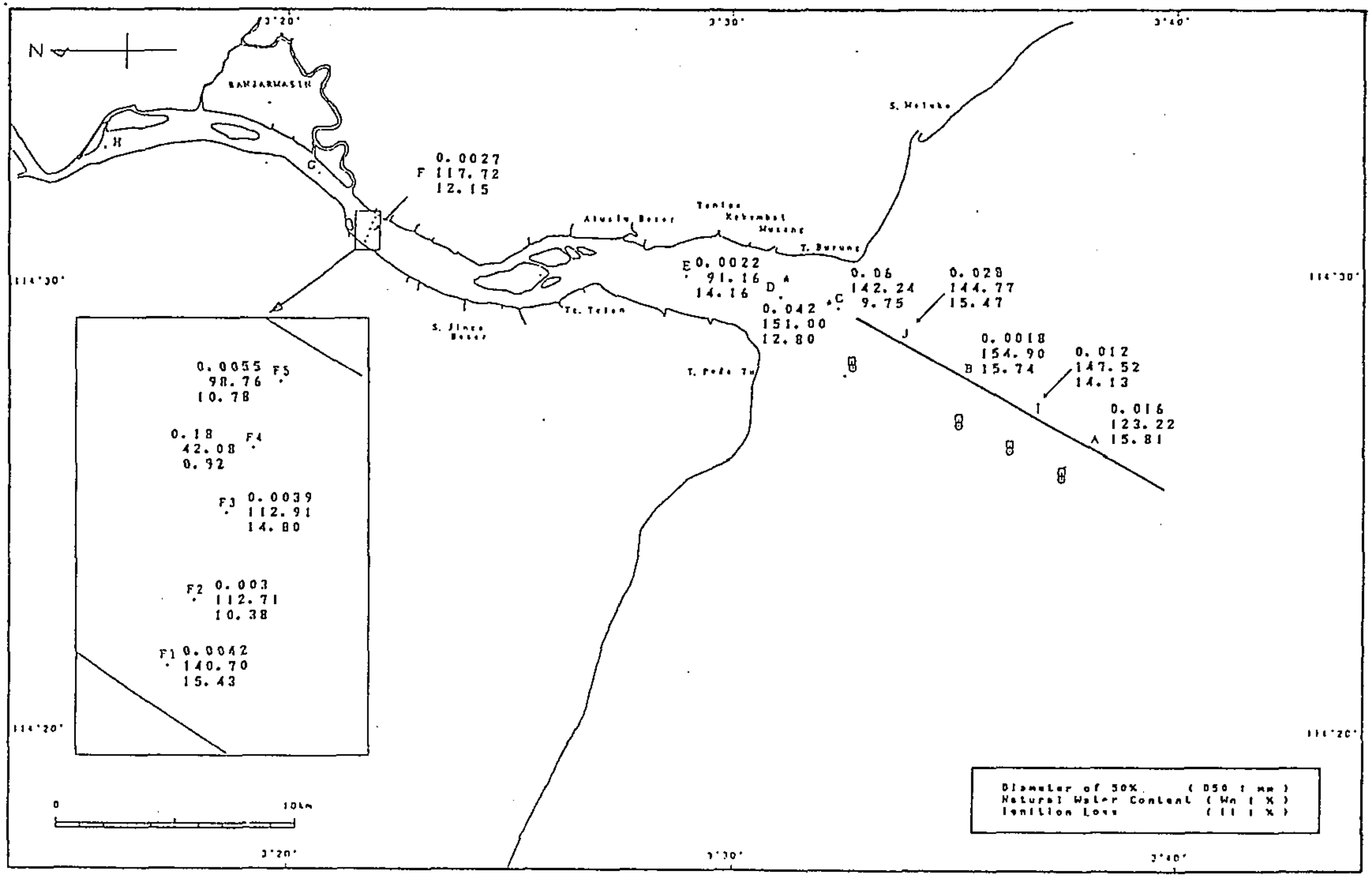


Fig. 5.2.3-1(4) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

5 th Monthly Survey

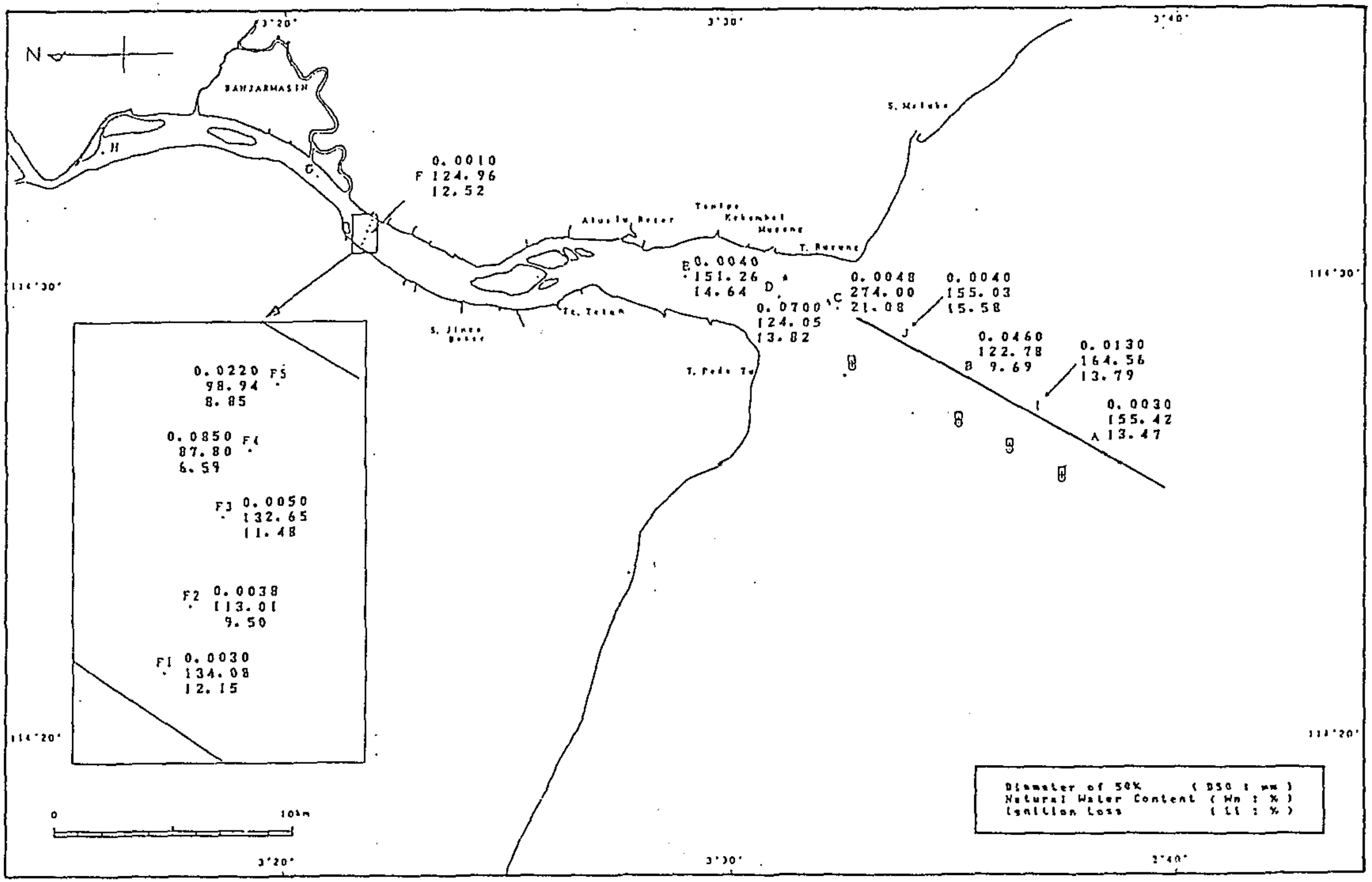


Fig. 5.2.3-1(5) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

6 th Monthly Survey

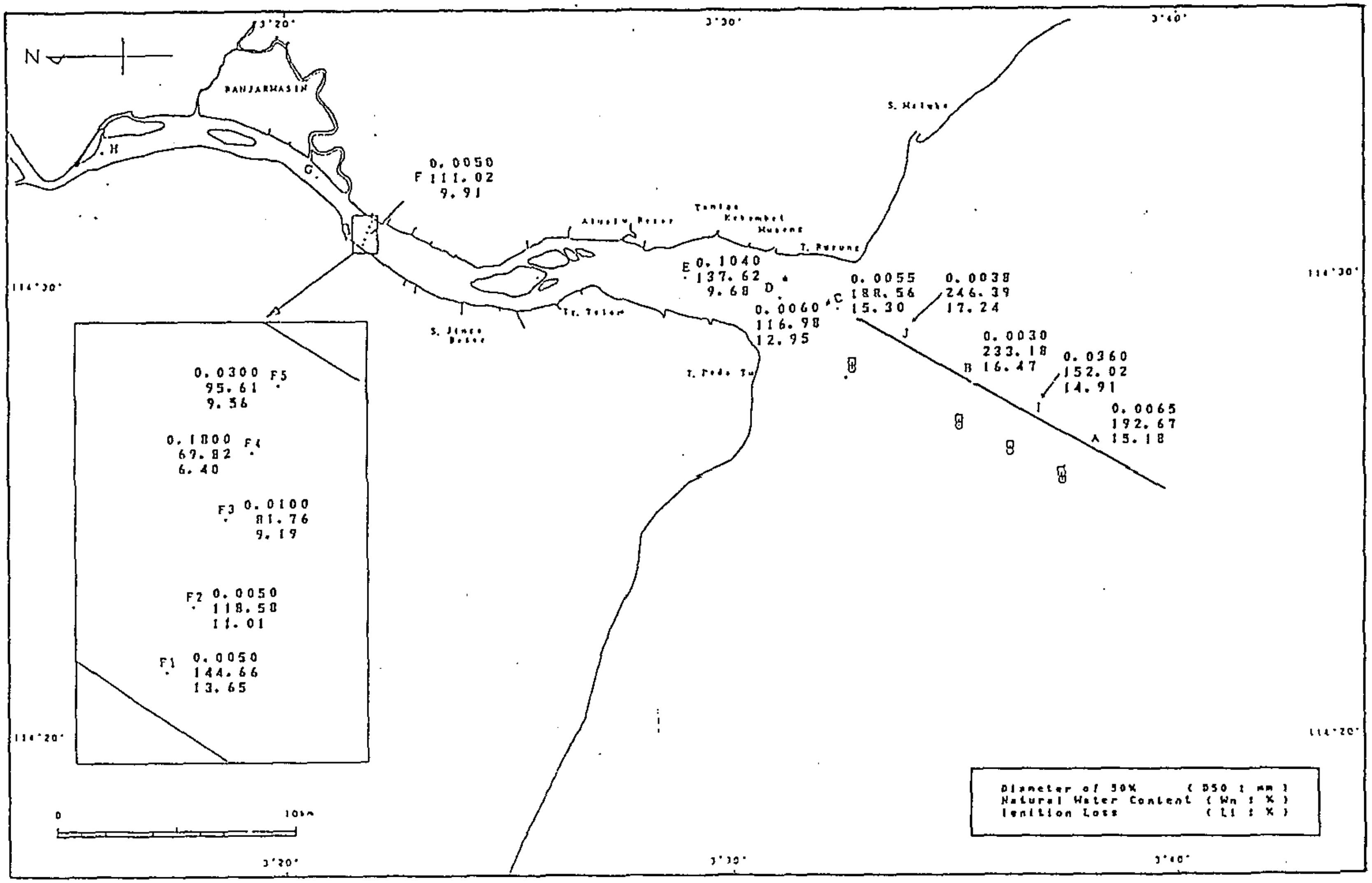


Fig. 5.2.3-1(6) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

7 th Monthly Survey

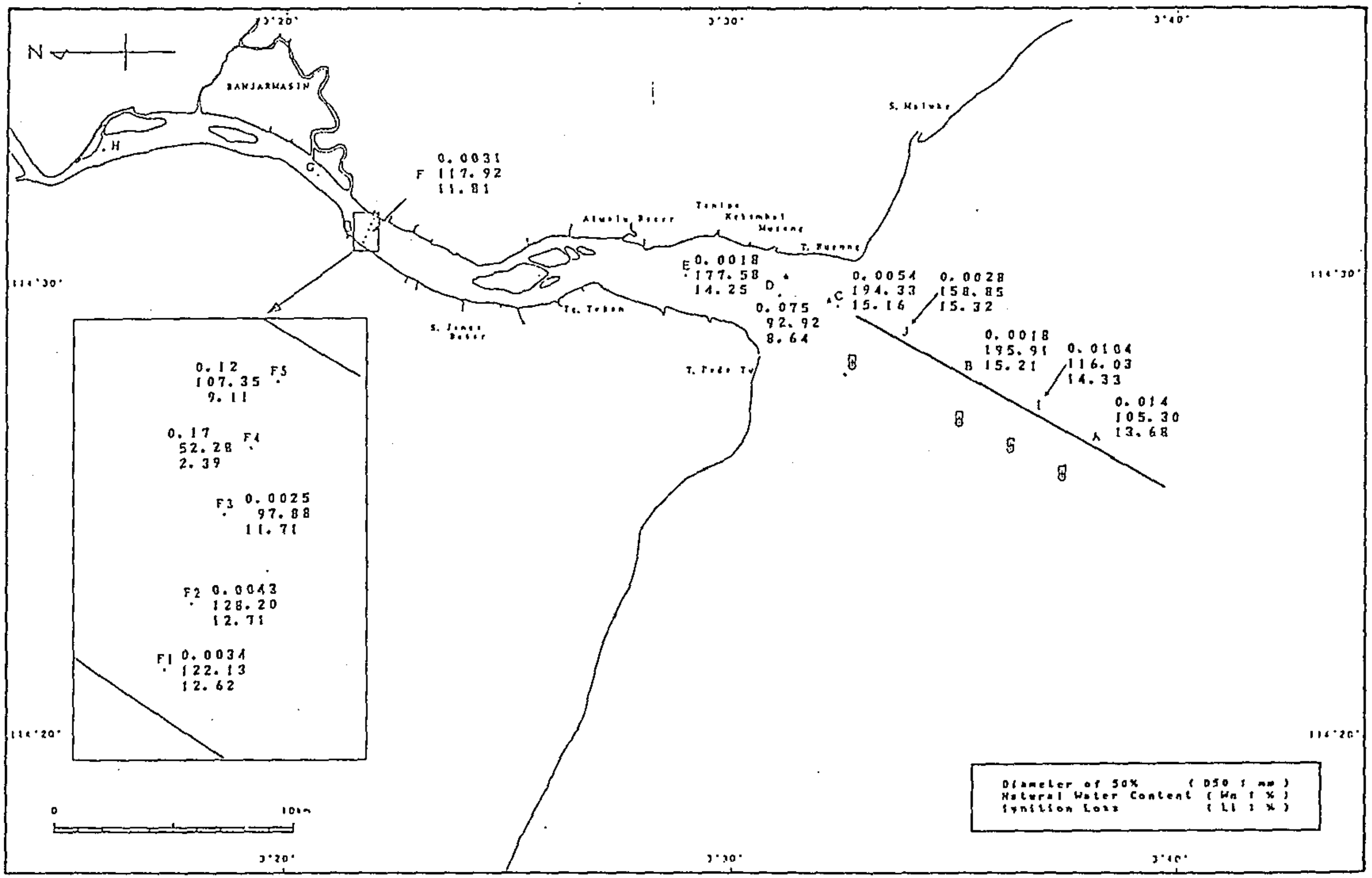


Fig. 5.2.3-1(7) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

8 th Monthly Survey

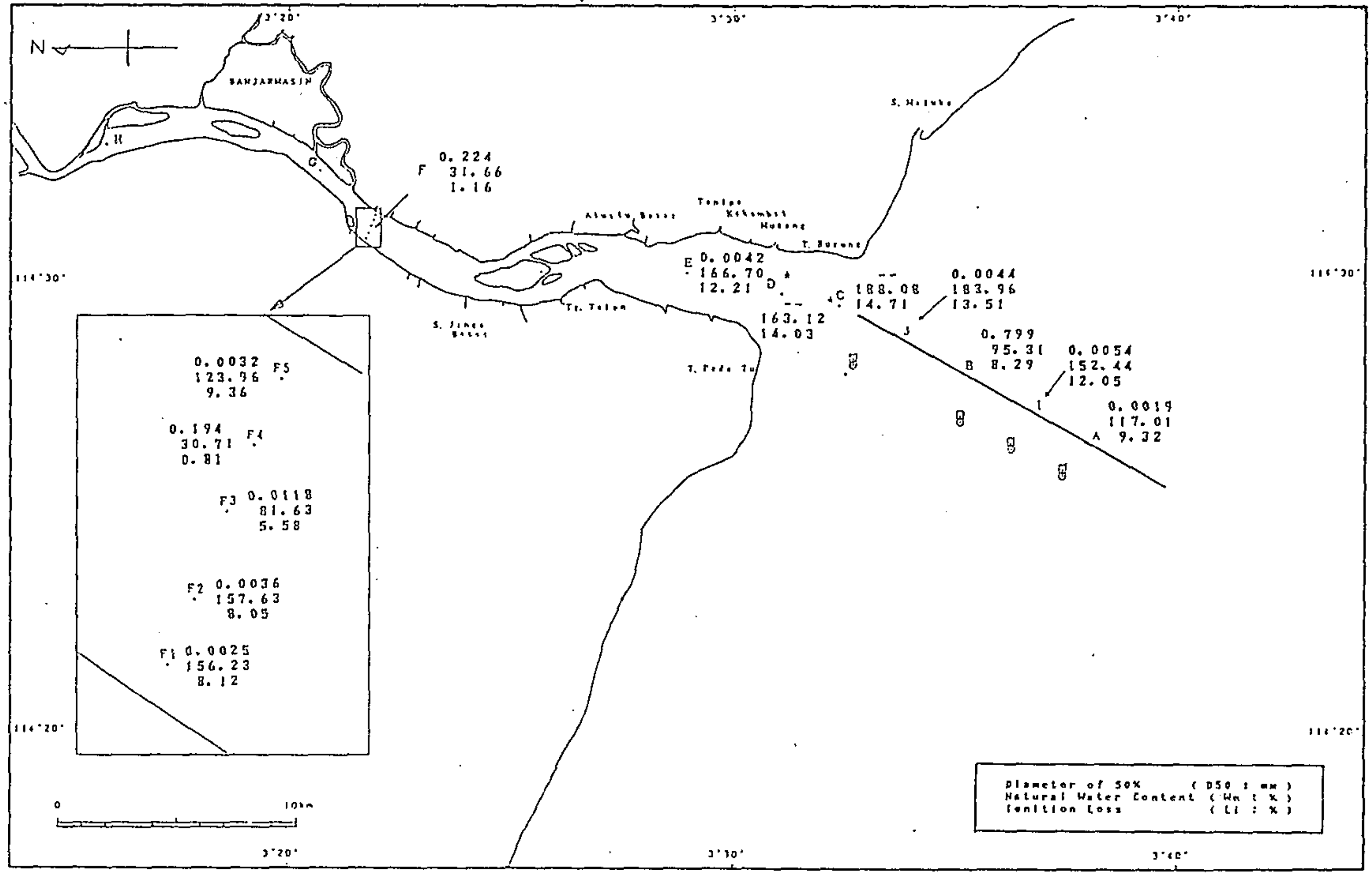


Fig. 5.2.3-1(8) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

9 th Monthly Survey

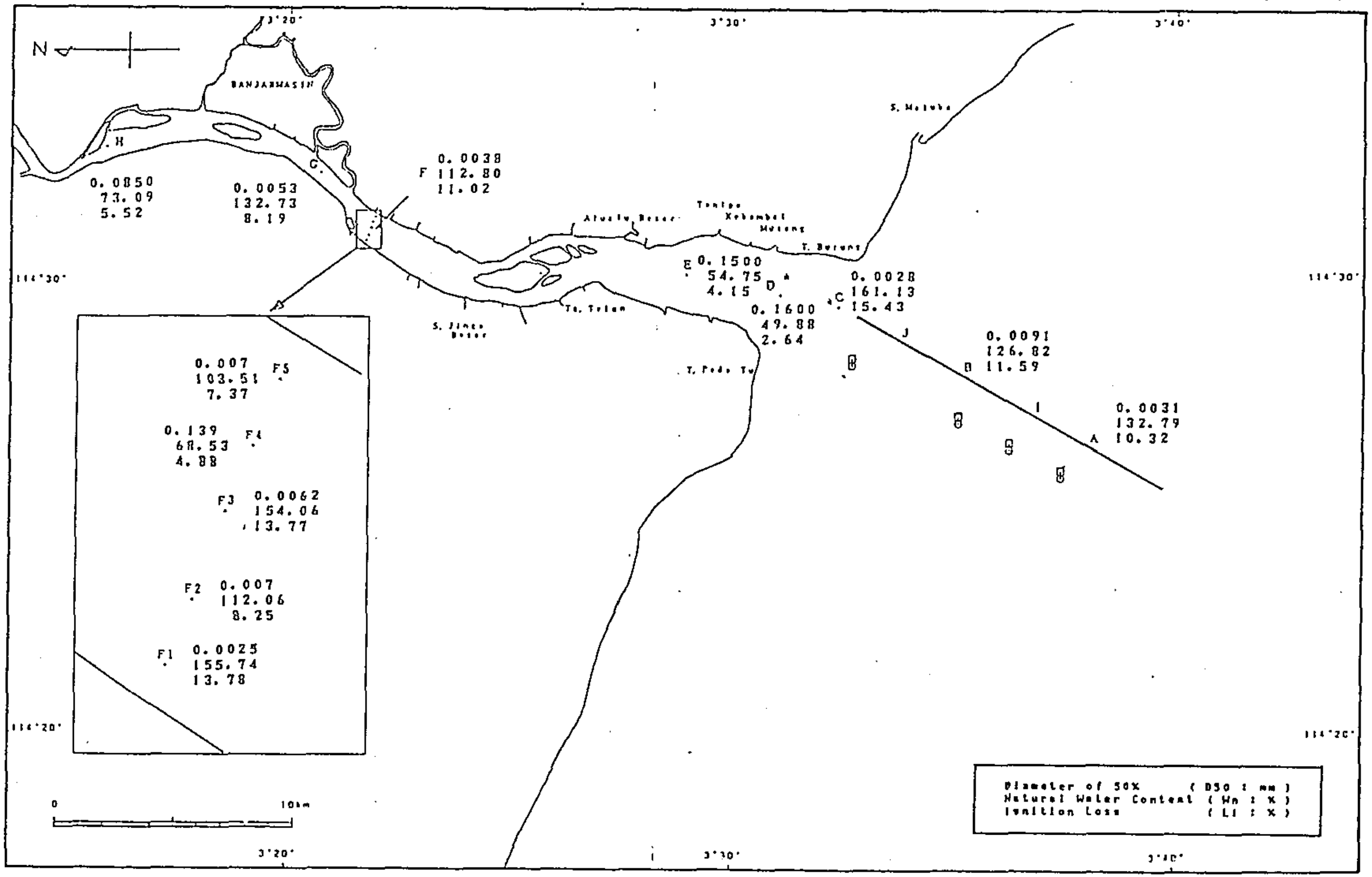


Fig. 5.2.3-1(9) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

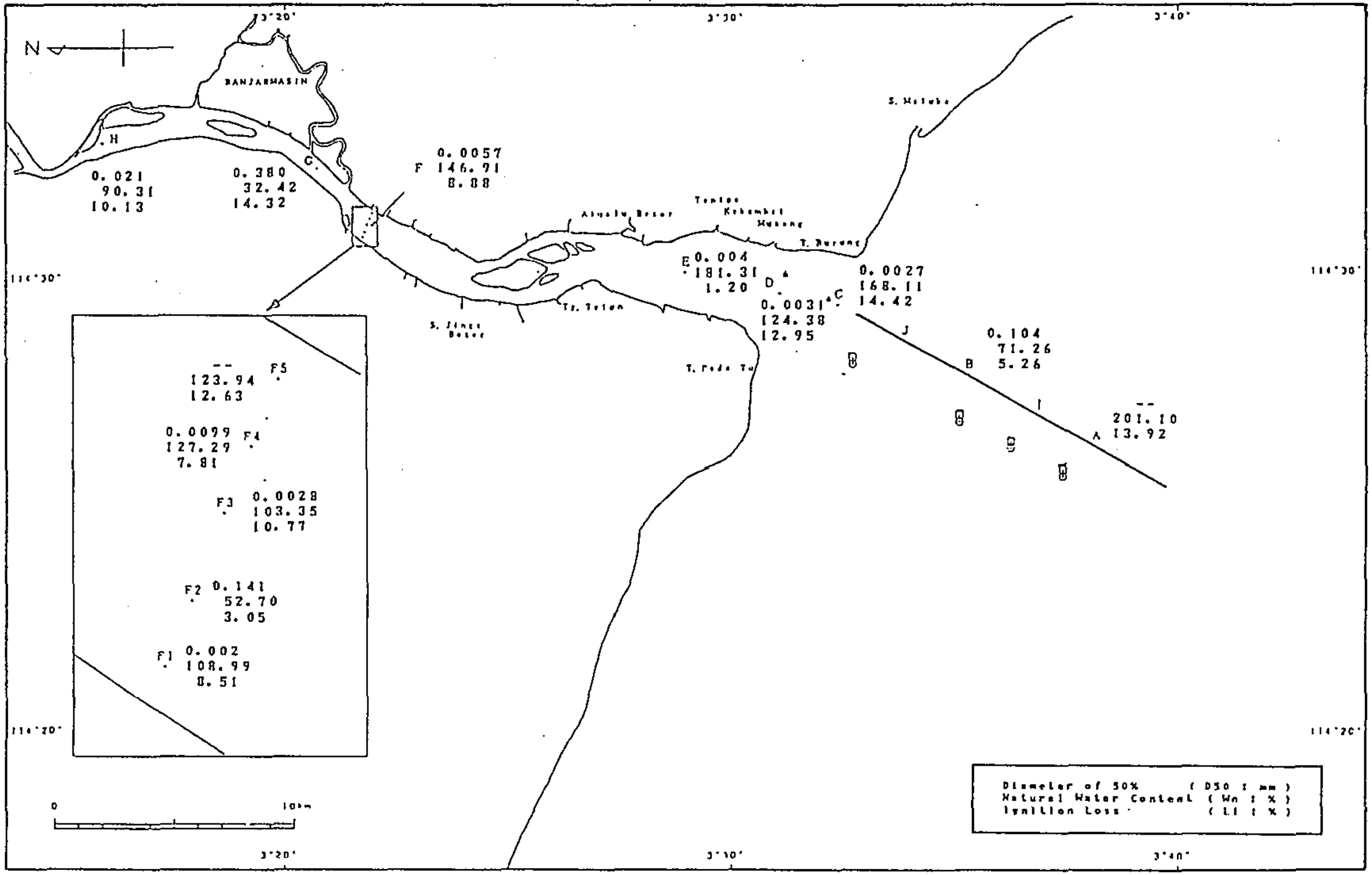


Fig. 5.2.3-1(10) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

11th Monthly Survey

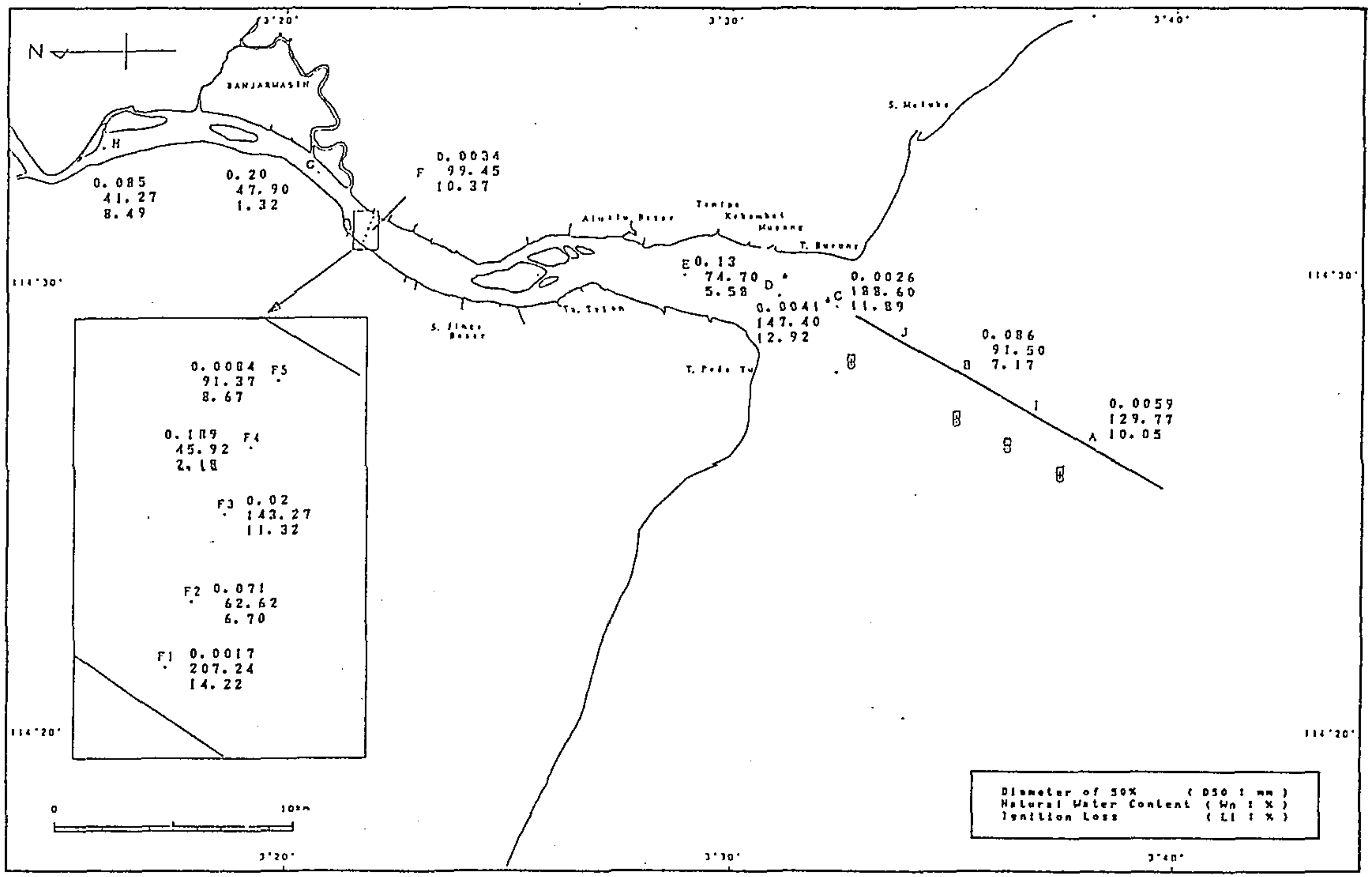


Fig. 5.2.3-1(11) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

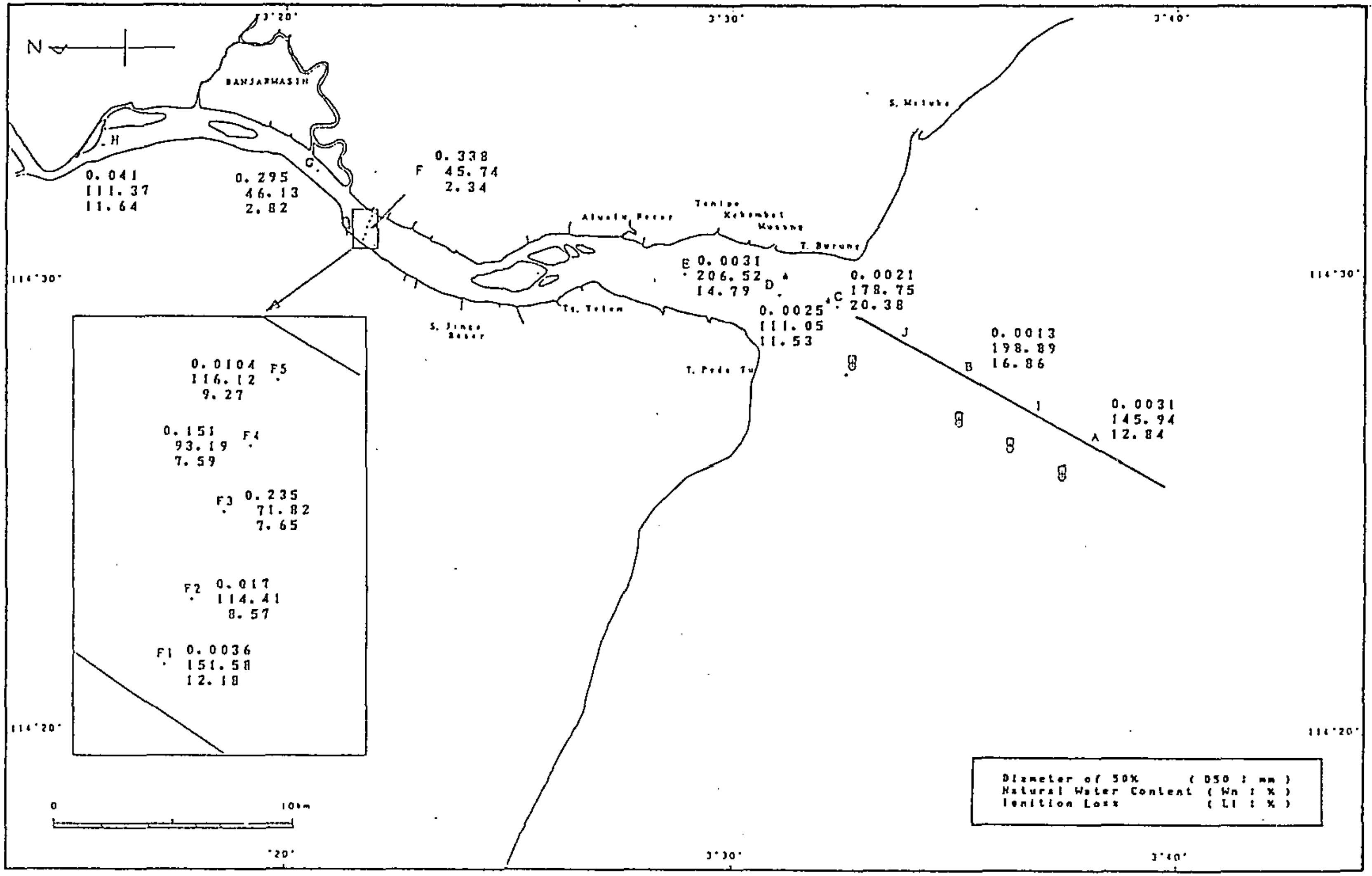


Fig. 5.2.3-1(12) Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

1st Monthly Survey

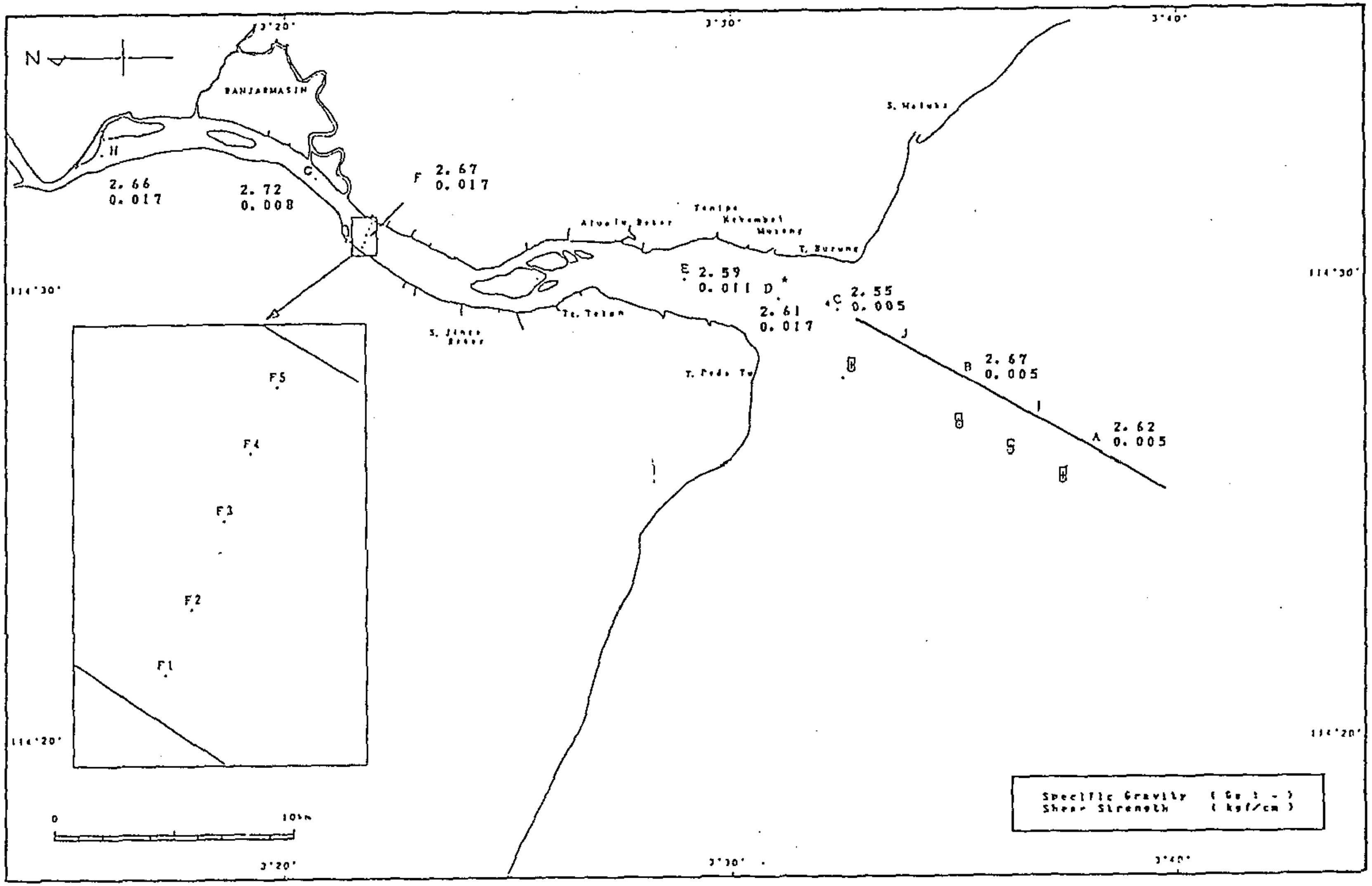


Fig. 5.2.3-2(1) Specific Gravity and Shear Strength

2 nd Monthly Survey

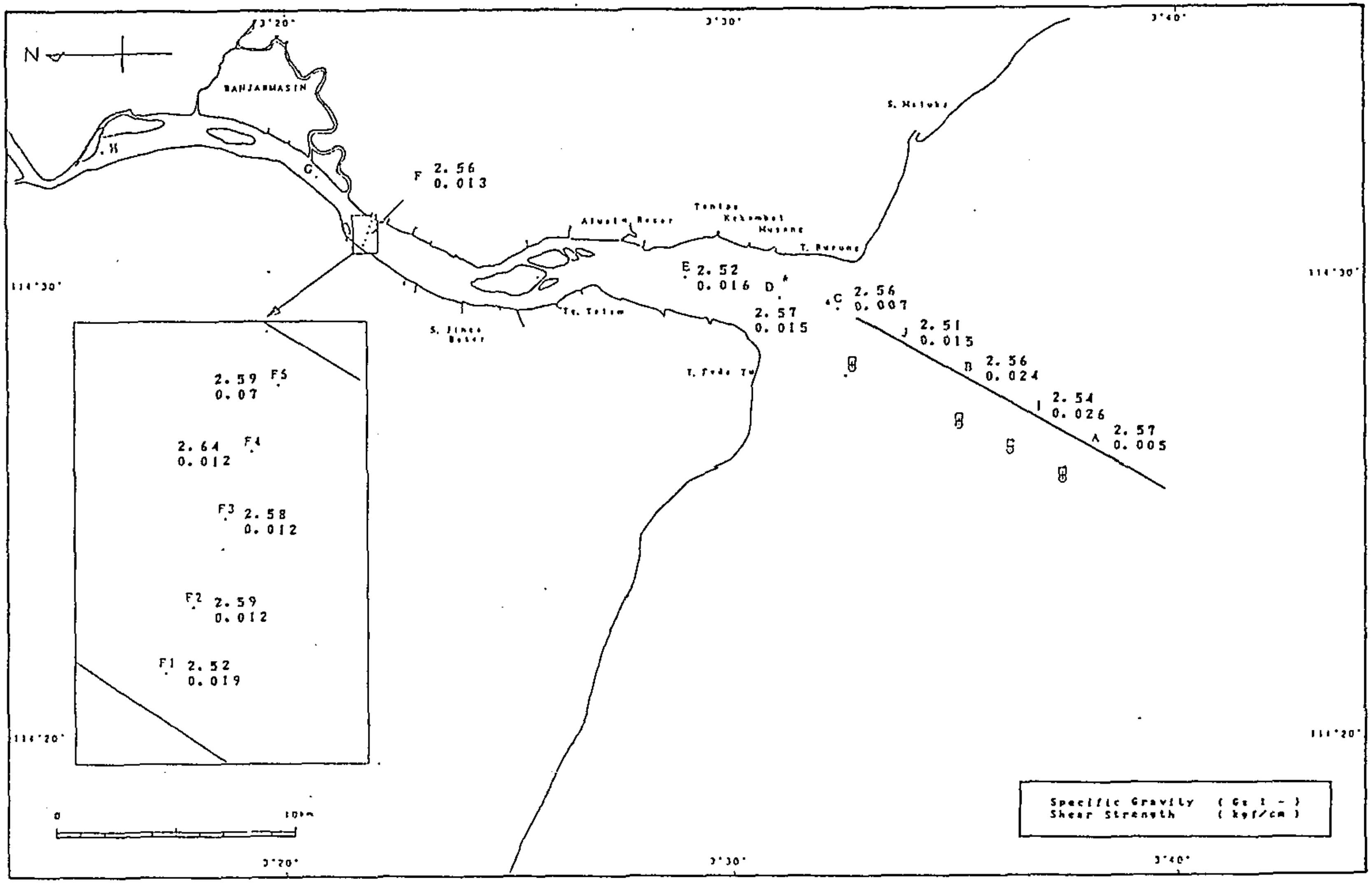


Fig. 5.2.3-2(2) Specific Gravity and Shear Strength

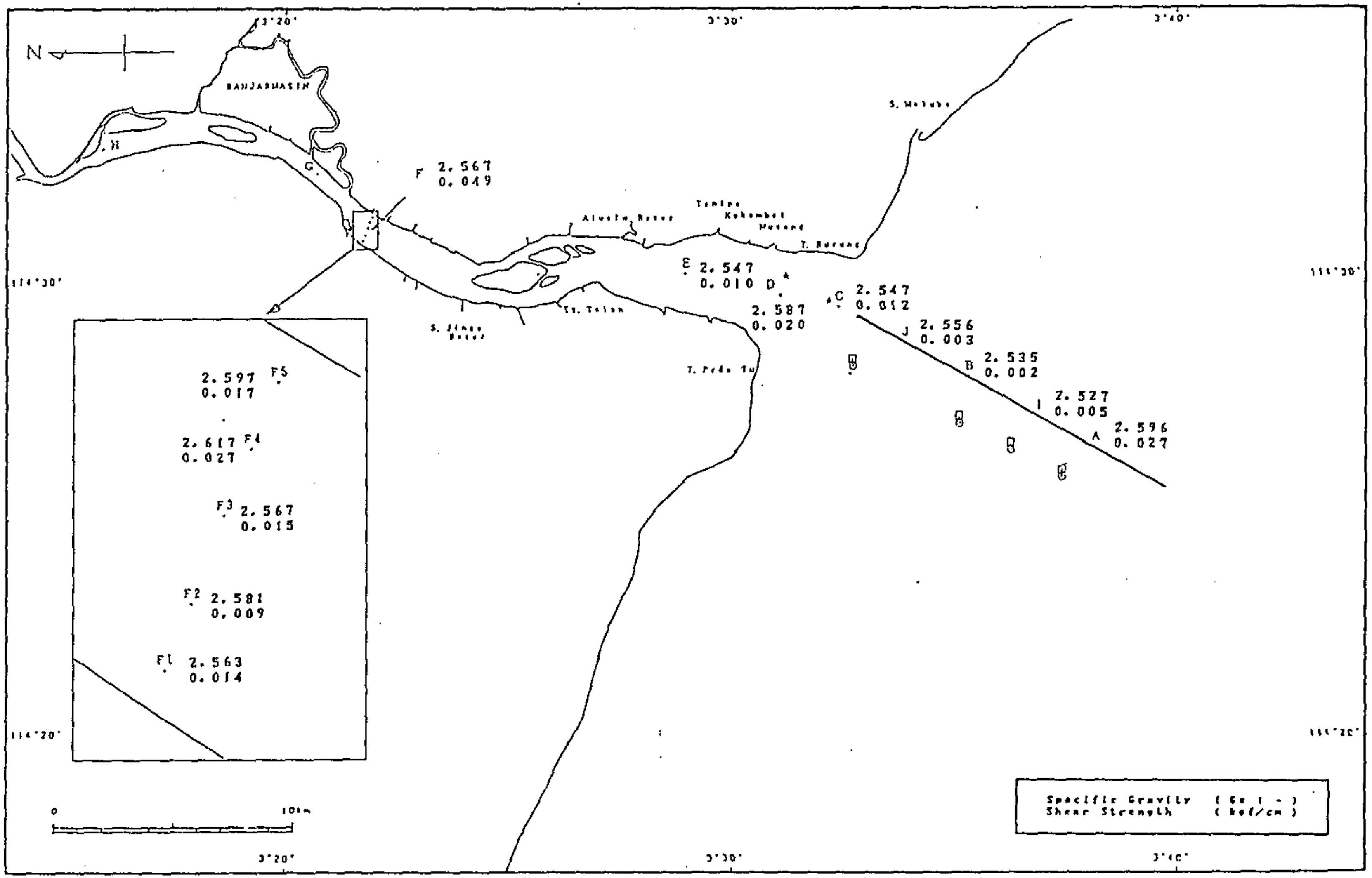


Fig. 5.2.3-2(3) Specific Gravity and Shear Strength

4 th Monthly Survey

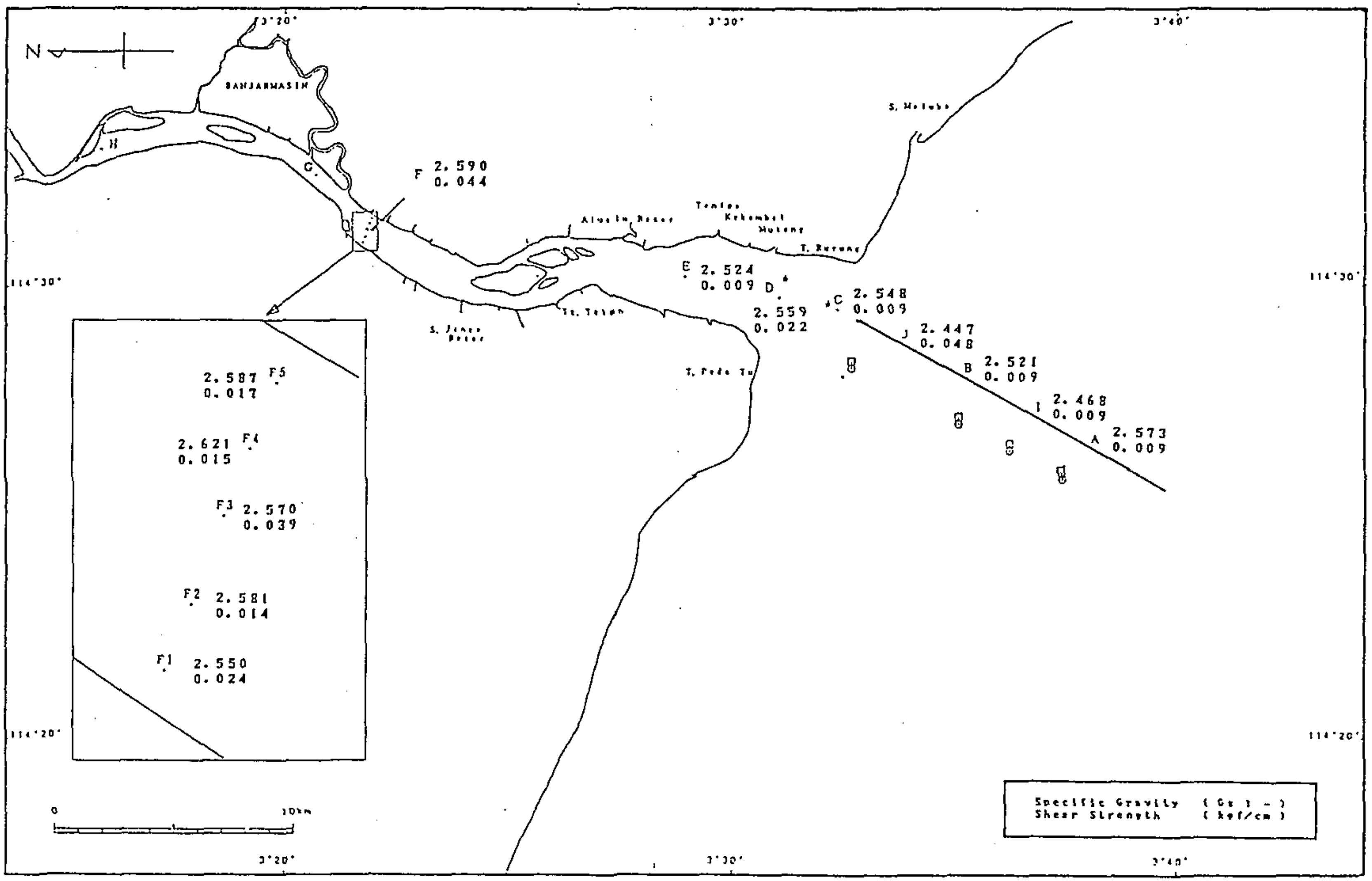


Fig. 5.2.3-2(4) Specific Gravity and Shear Strength

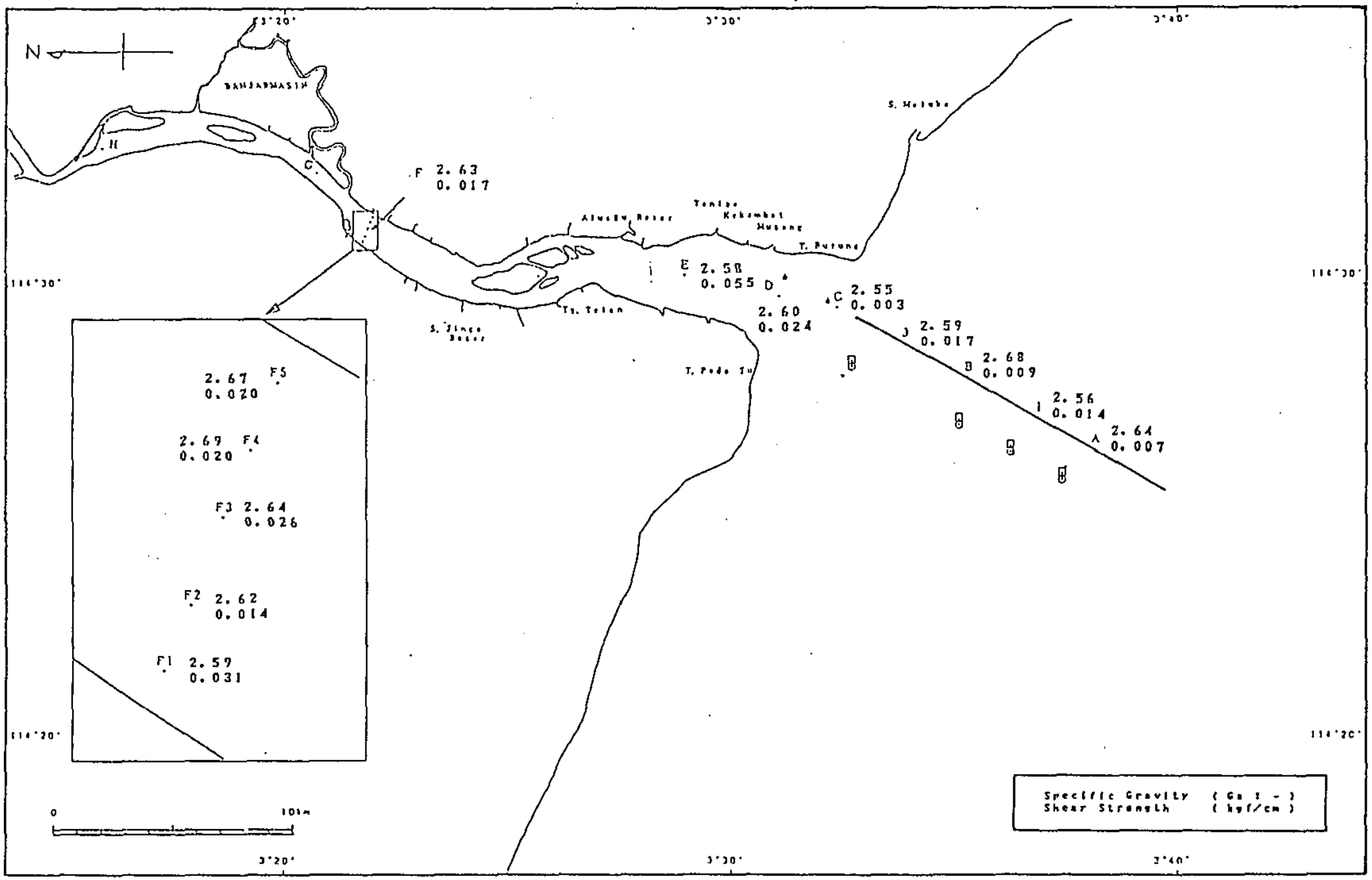


Fig. 5.2.3-2(5) Specific Gravity and Shear Strength

6 th Monthly Survey

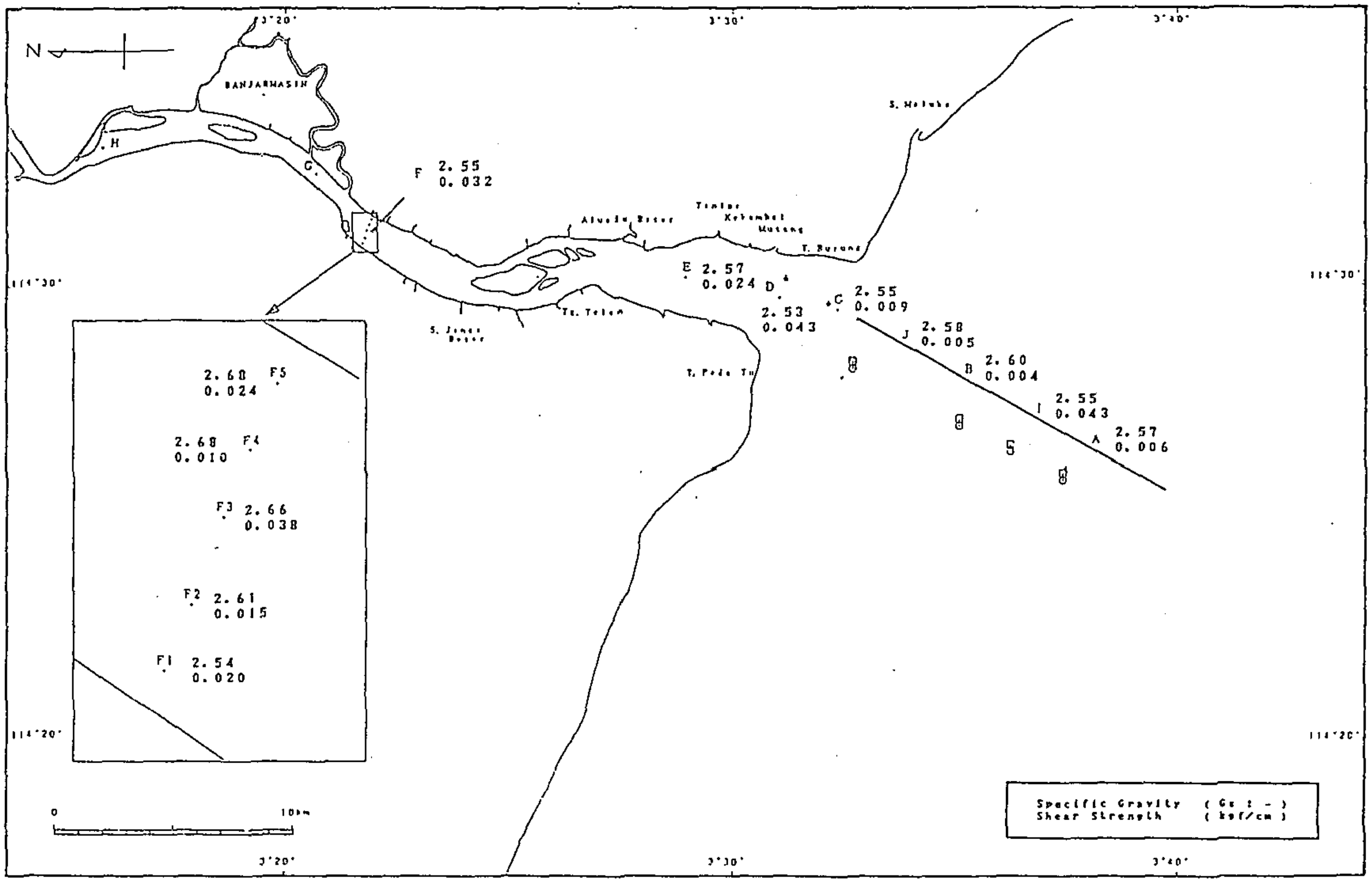


Fig. 5.2.3-2(6) Specific Gravity and Shear Strength

7 th Monthly Survey

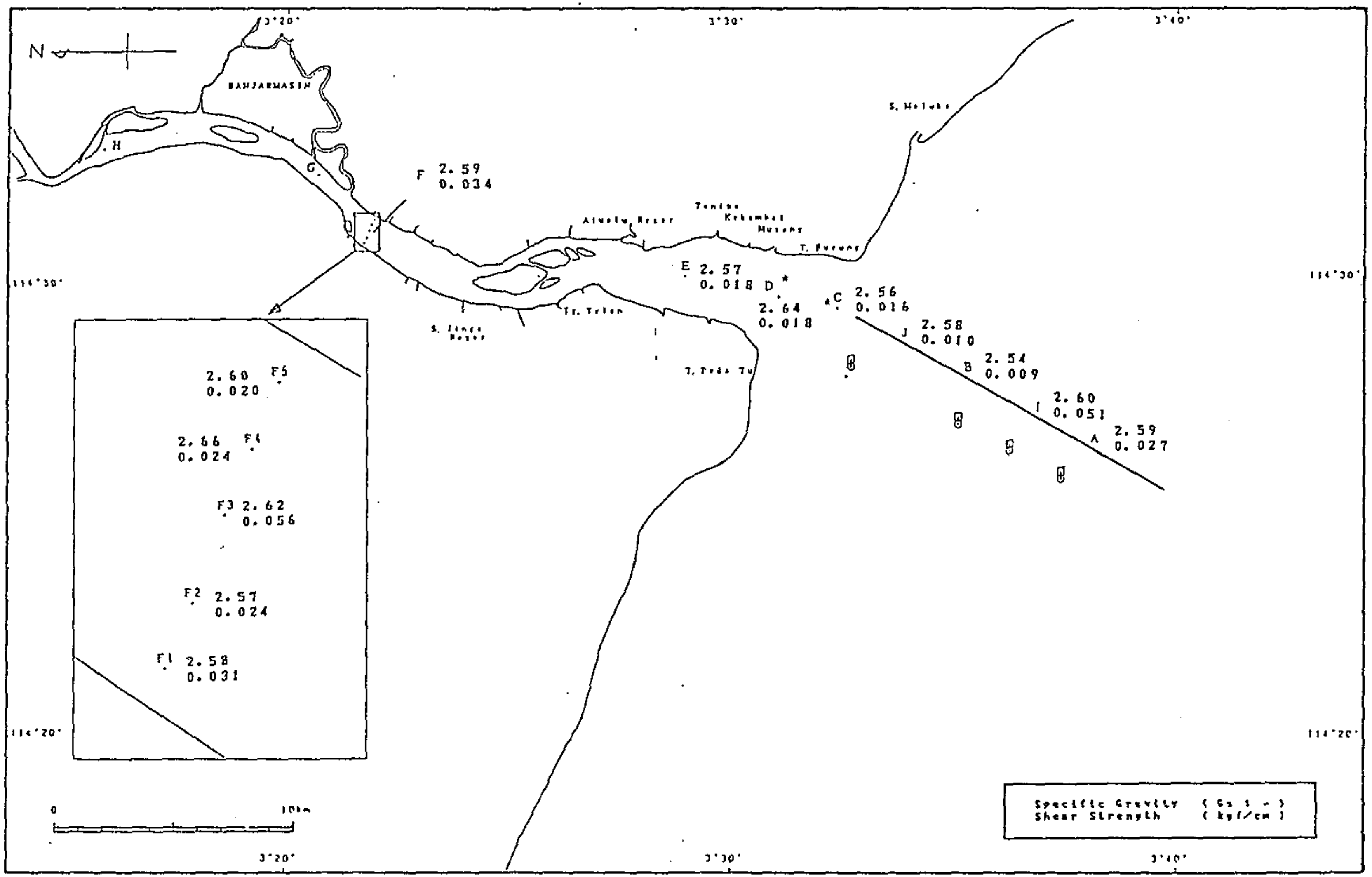


Fig. 5.2.3-2(7) Specific Gravity and Shear Strength

8 th Monthly Survey

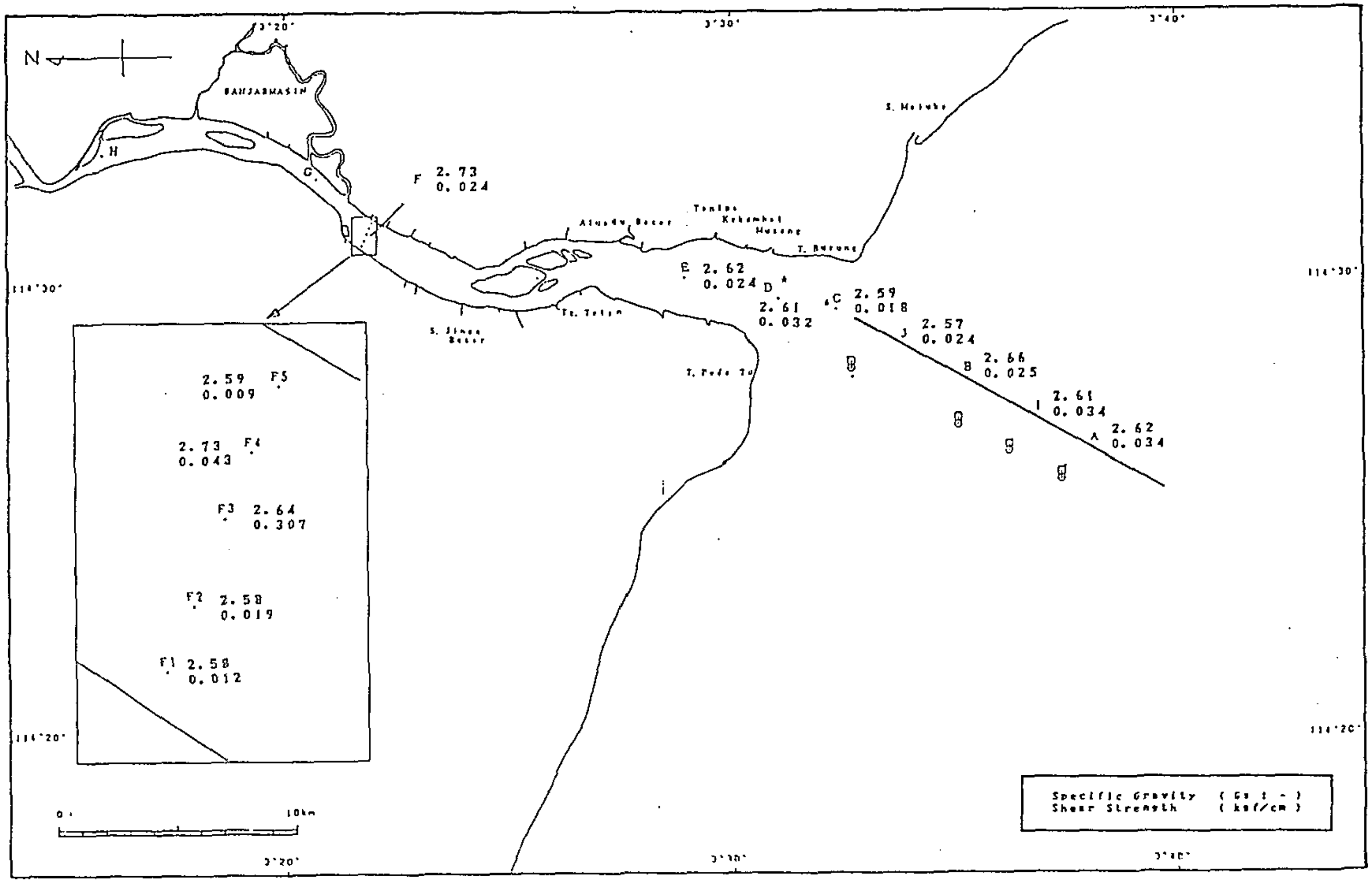


Fig. 5.2.3-2(8) Specific Gravity and Shear Strength

9 th Monthly Survey

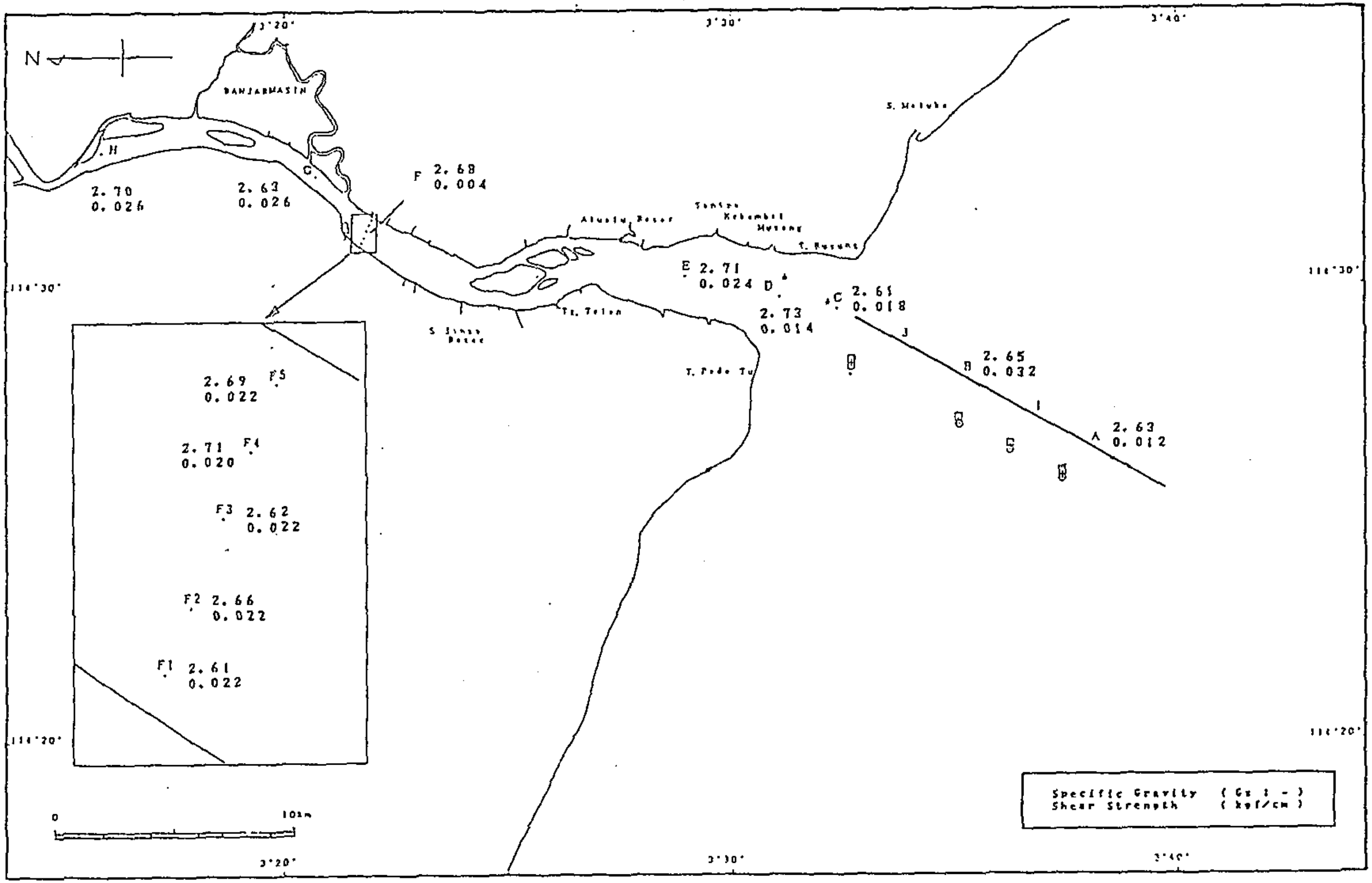


Fig. 5.2.3-2(9) Specific Gravity and Shear Strength

10th Monthly Survey

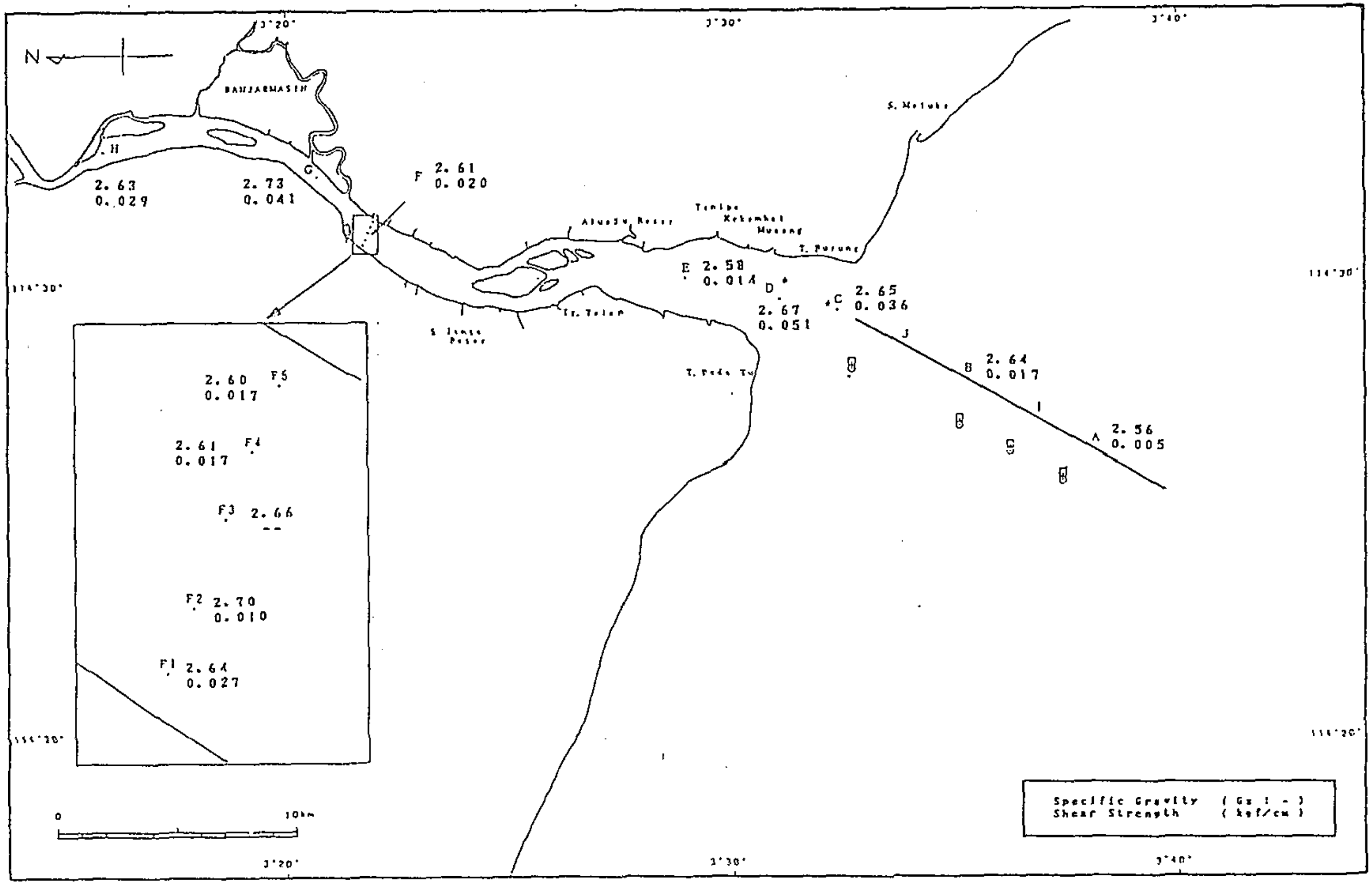


Fig. 5.2.3-2(10) Specific Gravity and Shear Strength

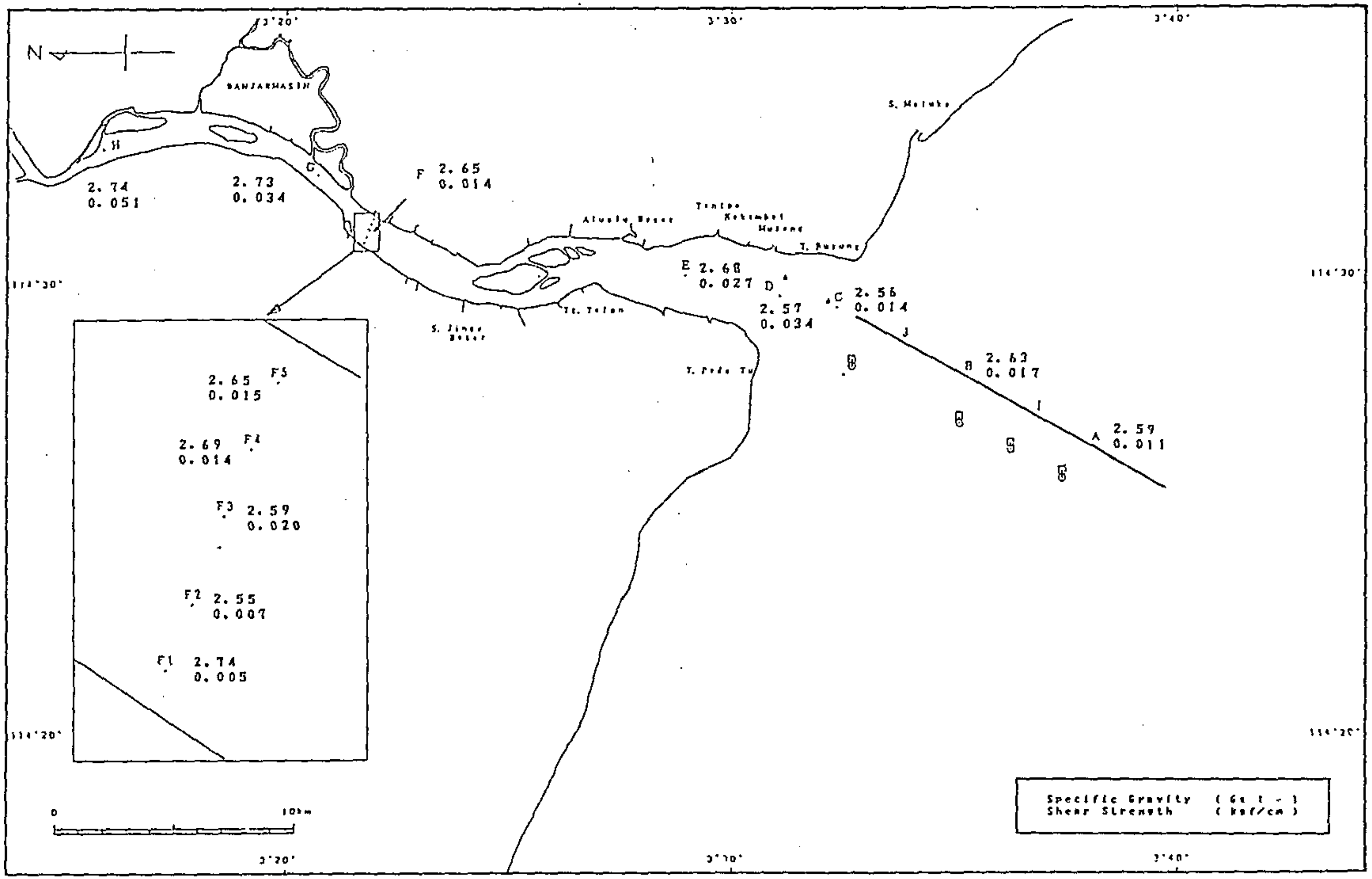


Fig. 5.2.3-2(11) Specific Gravity and Shear Strength

12th Monthly Survey

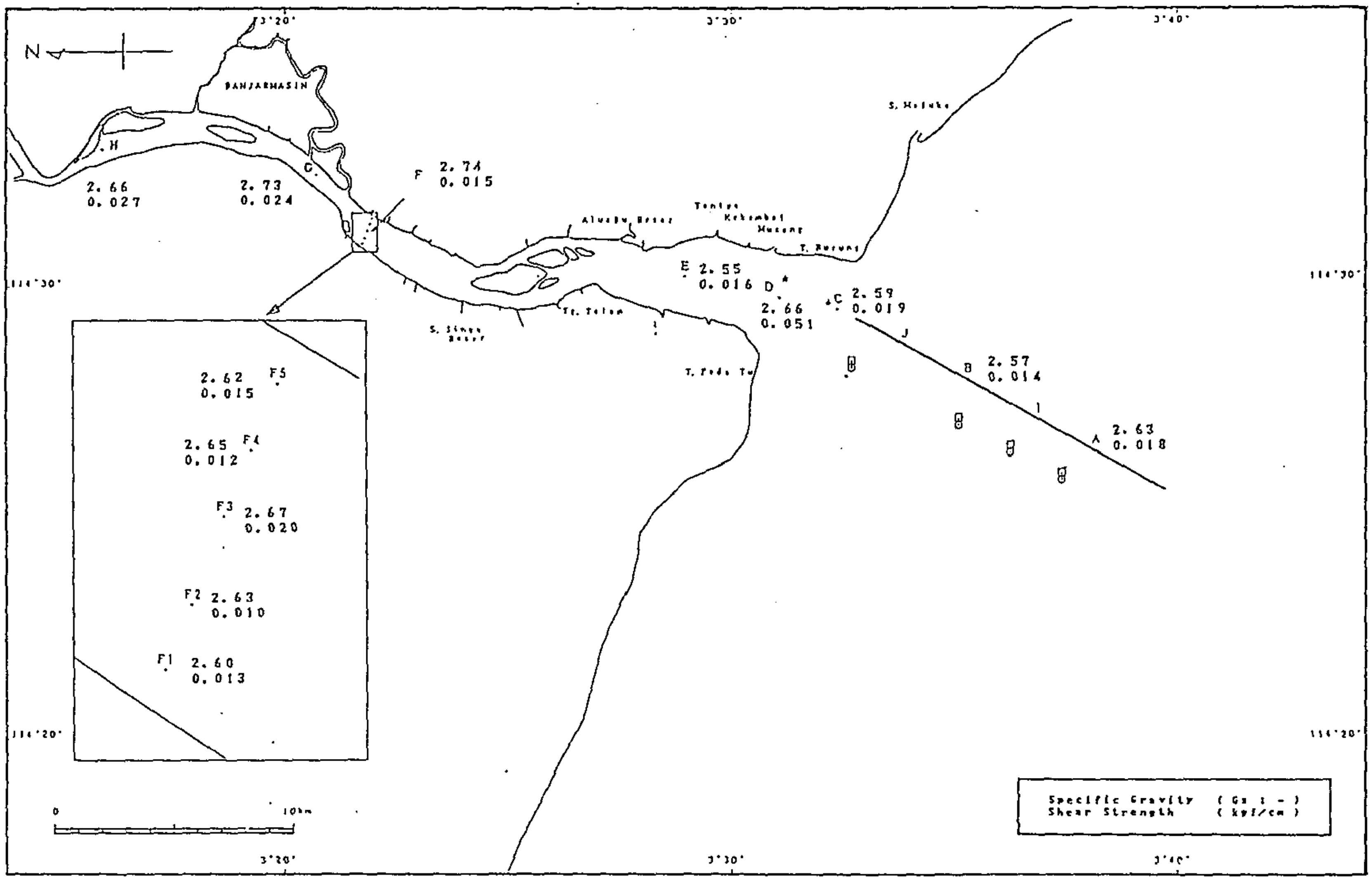


Fig. 5.2.3-2(12) Specific Gravity and Shear Strength

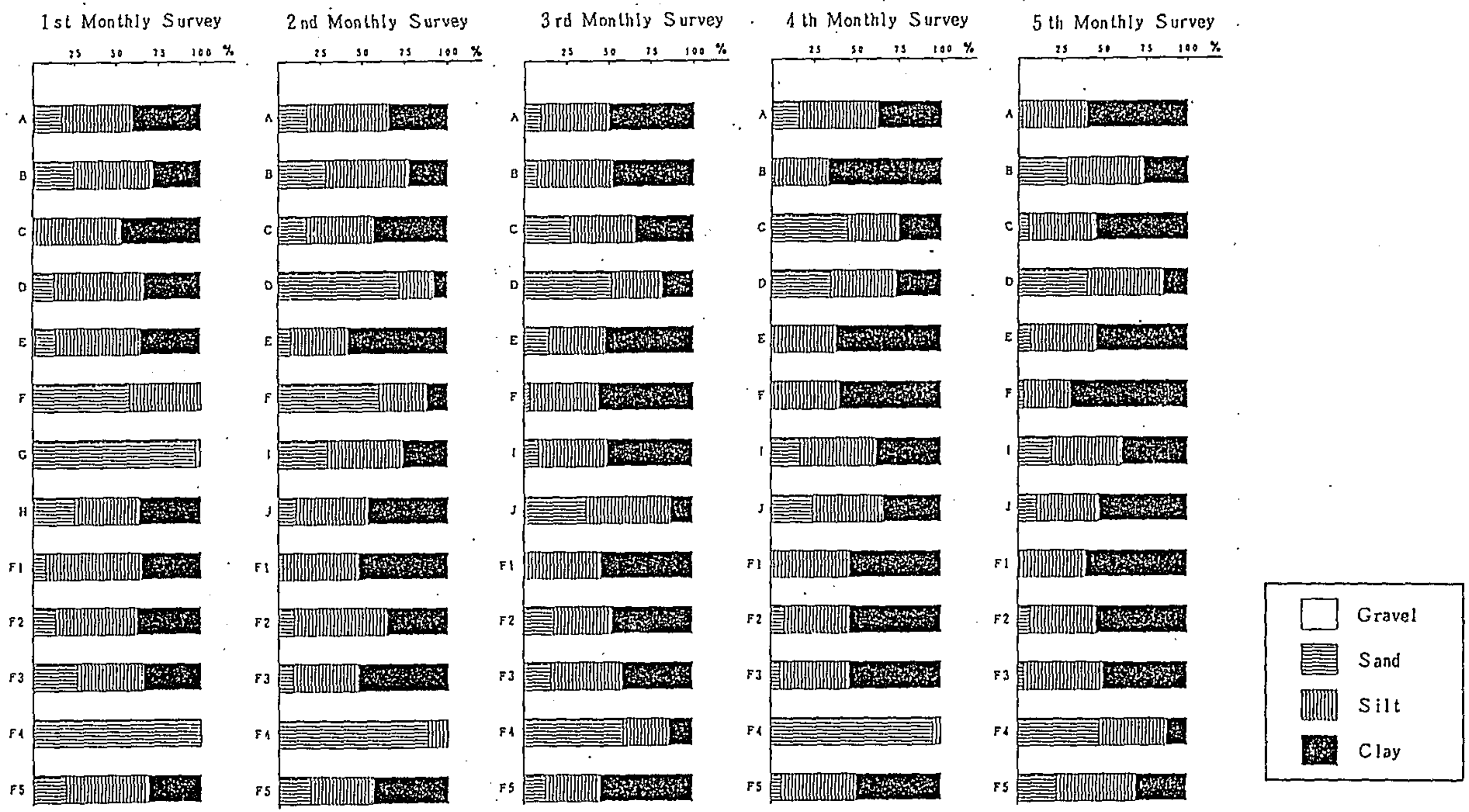


Fig. 5.2.3-3(1) Grain Size Distribution of Bottom Material

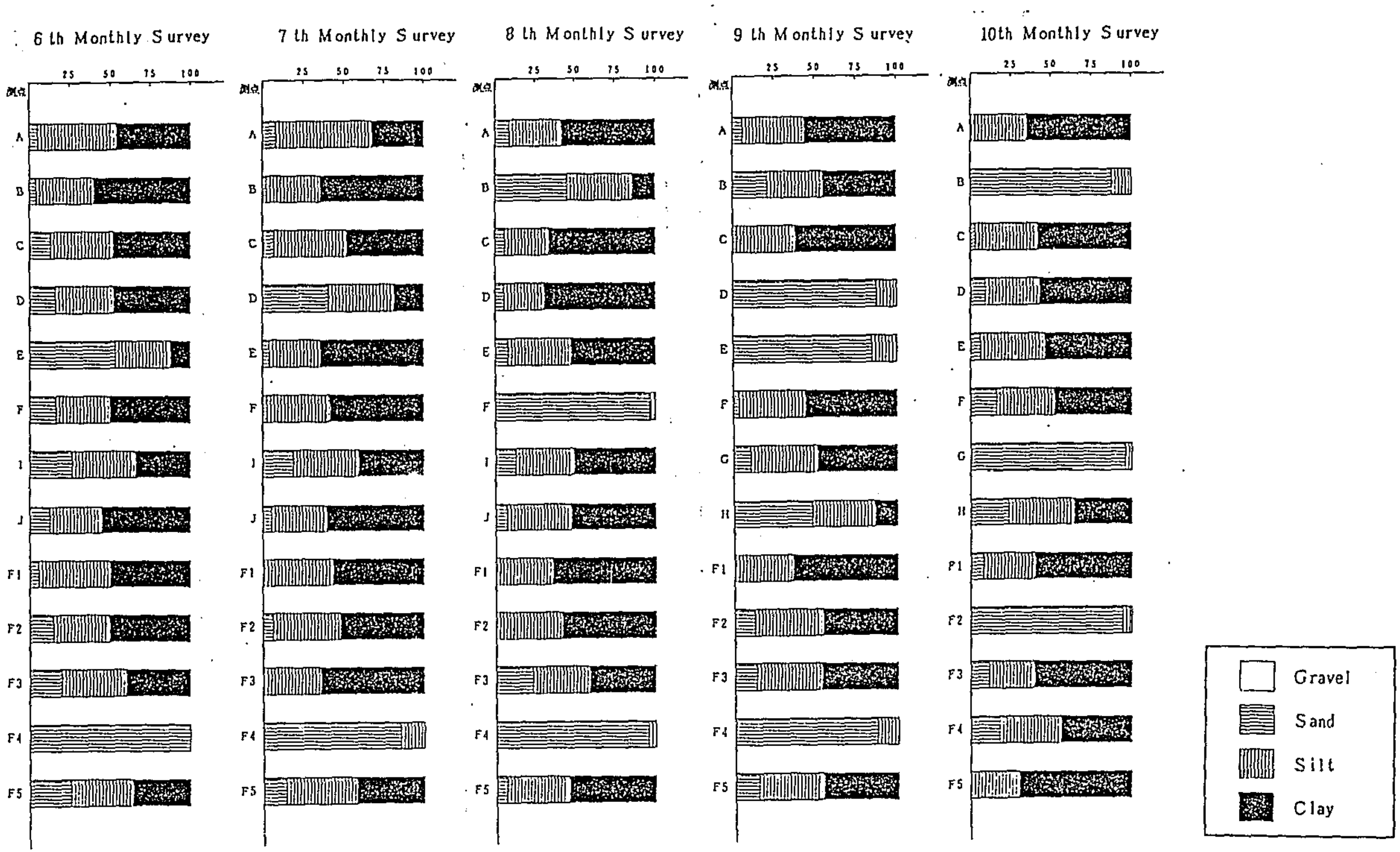


Fig. 5.2.3-3(2) Grain Size Distribution of Bottom Material

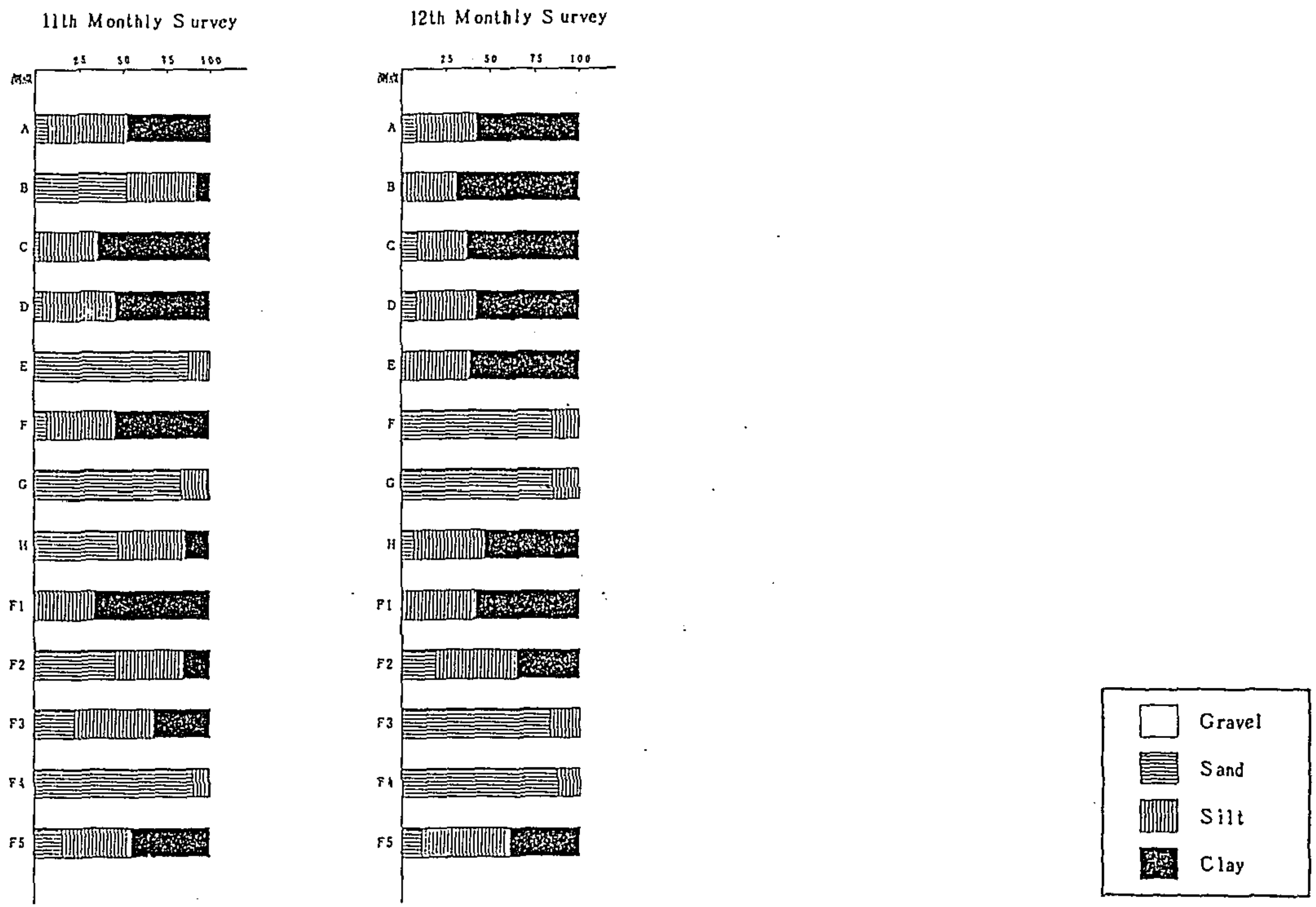


Fig. 5.2.3-3(3) Grain Size Distribution of Bottom Material

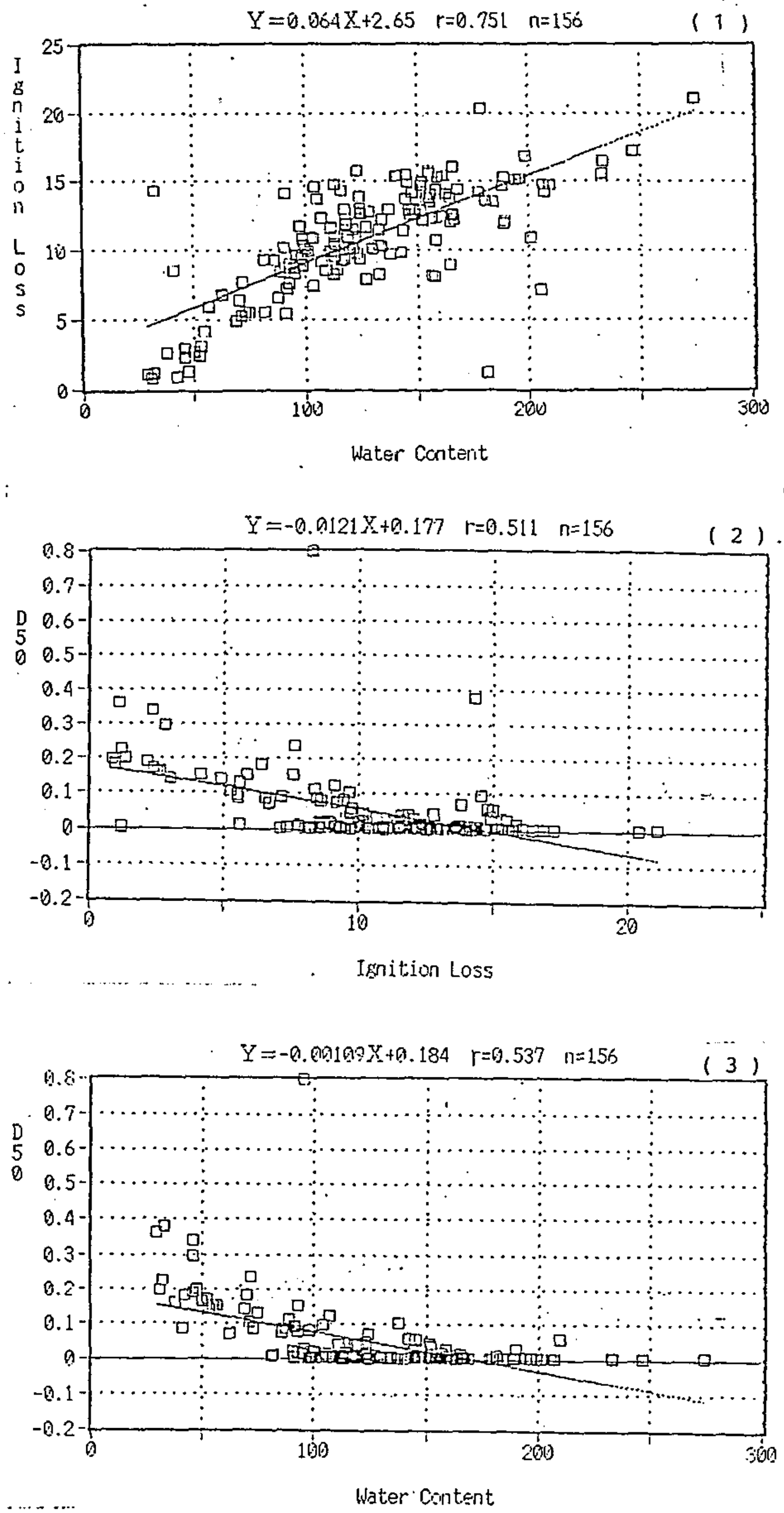
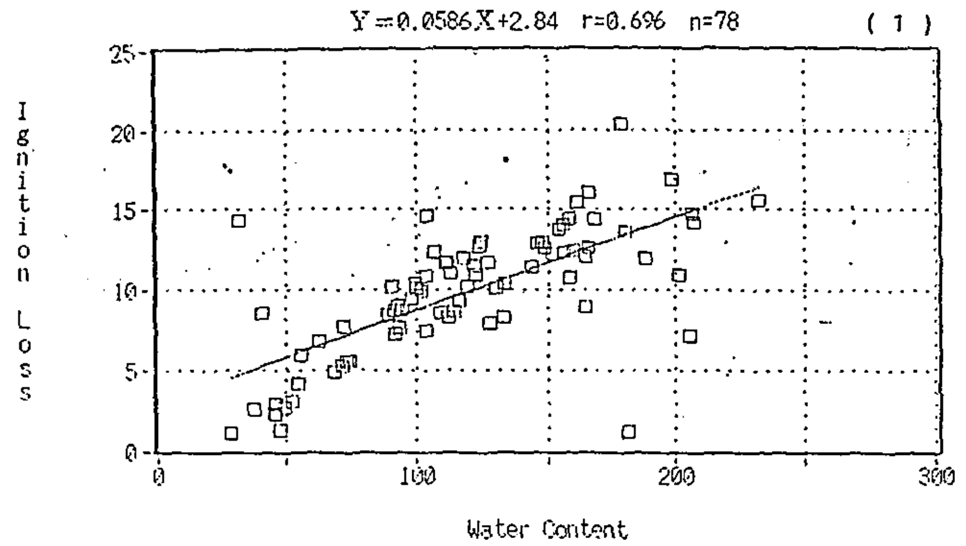
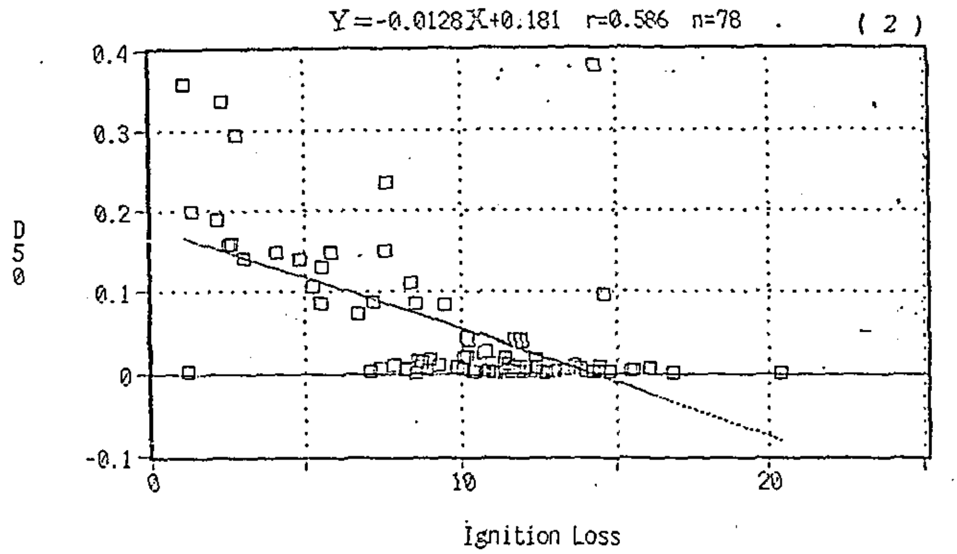


Fig. 5.2.3.-4(1) Correlation Diagram : ALL SEASON





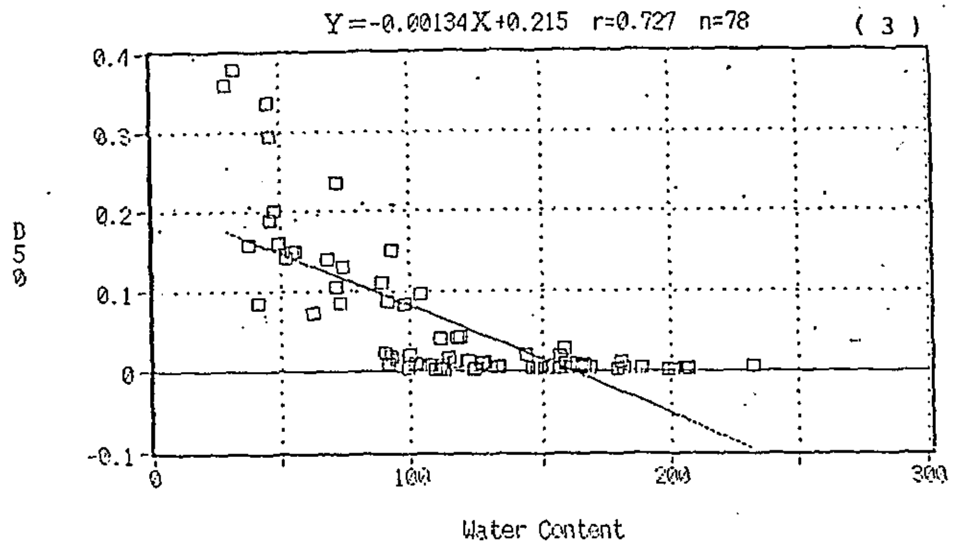
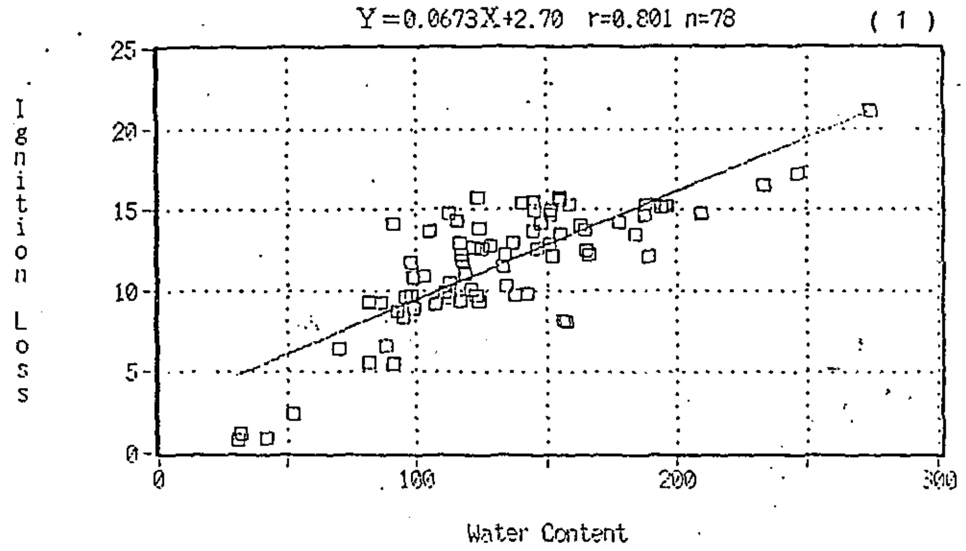
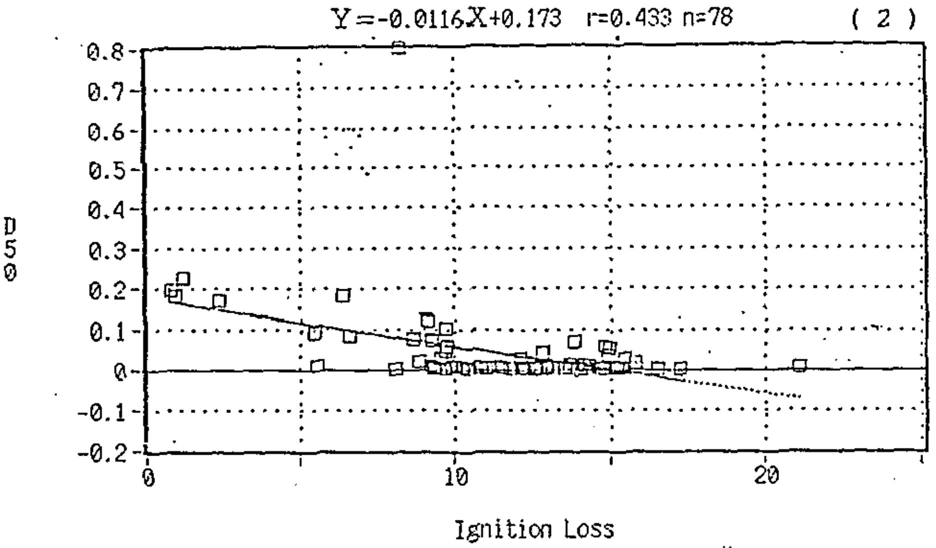


Fig. 5.2.3.-4(2) Correlation Diagram : DRY SEASON





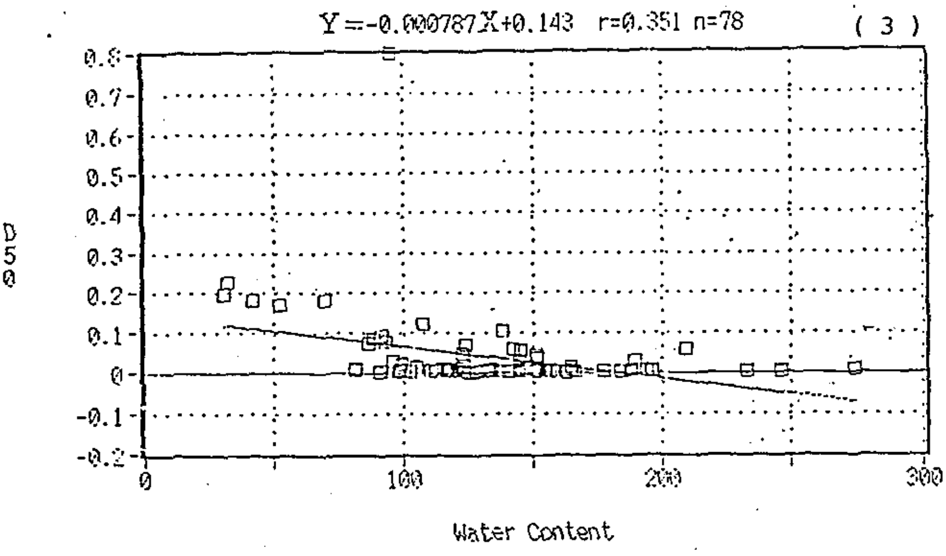


Fig. 5.2.3.-4(3) Correlation Diagram : RAINY SEASON

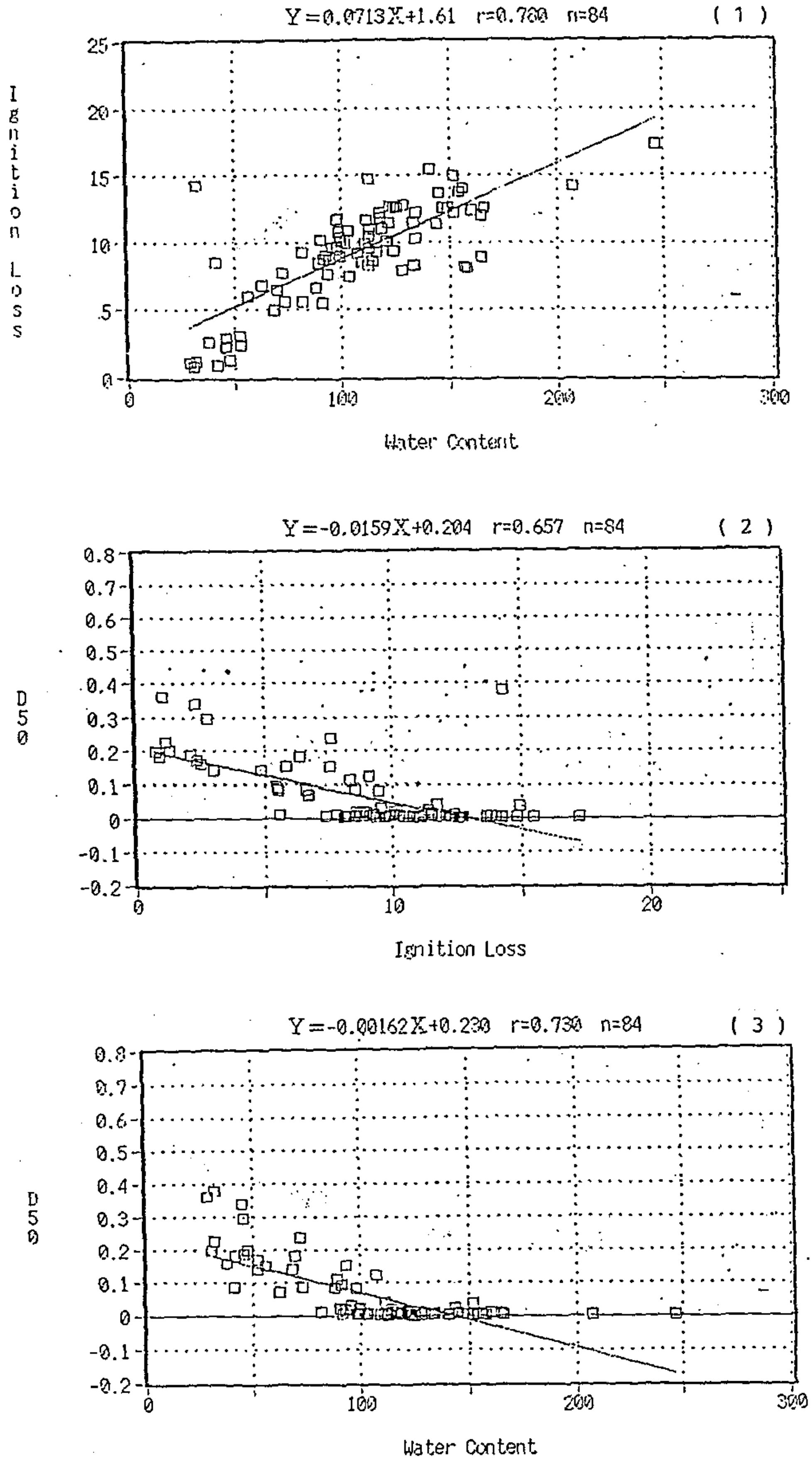


Fig. 5.2.3.-4(4) Correlation Diagram : River

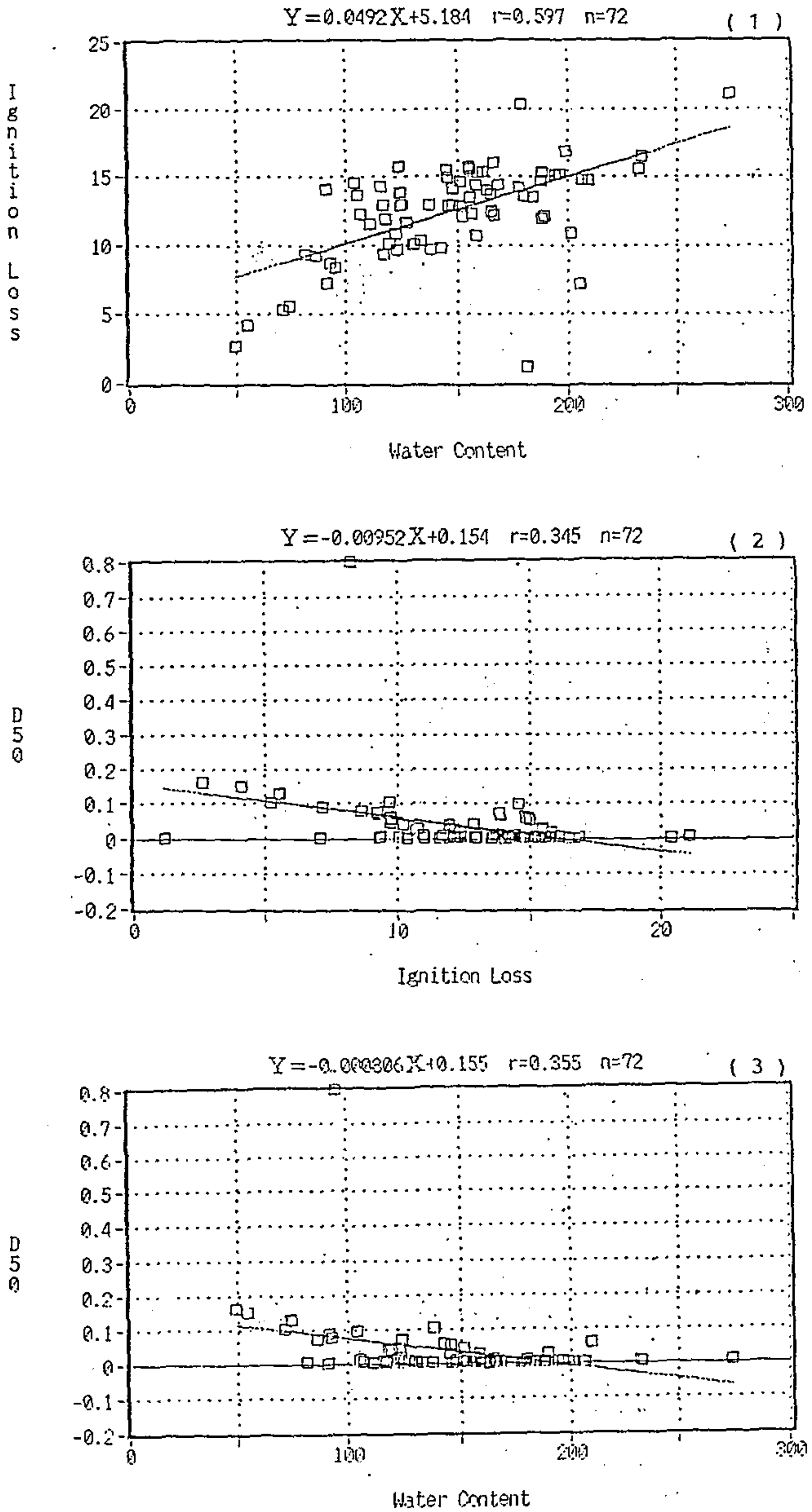


Fig. 5.2.3.-4(5) Correlation Diagram : Estuary - Channel

Table 5.2.3-1(1) Diameter of 50%, Natural Water Content, Ignition Loss of Bottom Material

1st Monthly Survey				2nd Monthly Survey				3rd Monthly Survey				4th Monthly Survey				5th Monthly Survey			
	D_{50}	Wn	Li		D_{50}	Wn	Li		D_{50}	Wn	Li		D_{50}	Wn	Li		D_{50}	Wn	Li
	mm	%	%		mm	%	%		mm	%	%		mm	%	%		mm	%	%
A	0.0076	107.1	12.28	A	0.019	156.61	12.30	A	0.0048	81.38	9.34	A	0.016	123.22	15.81	A	0.003	155.42	13.47
B	0.027	158.1	10.70	B	0.042	119.12	10.18	B	0.06	209.48	14.80	B	0.0018	154.90	15.74	B	0.046	122.78	9.69
C	0.0055	232.3	15.56	C	0.009	158.20	14.43	C	0.0296	189.47	12.05	C	0.06	142.24	9.75	C	0.0048	274.00	21.08
D	0.012	122.2	10.87	D	0.095	103.96	14.55	D	0.072	85.95	9.24	D	0.042	151.00	12.80	D	0.07	124.05	13.82
E	0.01	180.3	13.57	E	0.0026	205.45	7.10	E	0.0048	165.42	12.48	E	0.0022	91.16	14.16	E	0.004	151.26	14.64
F	0.11	88.9	8.36	F	0.082	98.32	9.45	F	0.0034	102.55	10.93	F	0.0027	117.72	12.15	F	0.001	124.96	12.52
G	0.36	29.1	1.10	I	0.04	118.30	11.88	I	0.0045	137.0	12.87	I	0.012	147.52	14.13	I	0.013	164.56	13.79
H	0.018	92.9	8.96	J	0.007	165.69	16.09	J	0.055	145.56	14.98	J	0.028	144.77	15.47	J	0.004	155.03	15.58
F1	0.0092	160.1	12.33	F1	0.0042	148.85	12.53	F1	0.004	146.59	12.55	F1	0.0042	140.70	15.43	F1	0.003	134.08	12.15
F2	0.0084	164.6	11.99	F2	0.02	99.89	10.02	F2	0.0065	134.29	10.26	F2	0.003	112.71	10.38	F2	0.0038	113.01	9.50
F3	0.0126	121.4	11.42	F3	0.004	166.02	12.56	F3	0.0092	121.12	10.06	F3	0.0039	112.91	14.80	F3	0.005	132.65	11.48
F4	0.158	37.5	2.55	F4	0.15	56.28	5.87	F4	0.09	91.12	5.47	F4	0.18	42.08	0.92	F4	0.085	87.80	6.59
F5	0.0142	94.7	8.71	F5	0.008	101.41	9.84	F5	0.003	98.01	9.71	F5	0.0055	98.76	10.78	F5	0.022	98.94	8.85

Diameter of 50% (D_{50} : mm)
Natural Water Content (Wn : %)
Ignition Loss (Li : %)

Table 5.2.3-1(2) Diameter of 50%, Natural Water Content, Ignition Loss of Bottom Material

6th Monthly Survey				7th Monthly Survey				8th Monthly Survey				9th Monthly Survey				10th Monthly Survey			
	D_{50} mm	Wn %	Li %		D_{50} mm	Wn %	Li %		D_{50} mm	Wn %	Li %		D_{50} mm	Wn %	Li %		D_{50} mm	Wn %	Li %
A	0.0065	192.67	15.18	A	0.014	105.30	13.68	A	0.0019	117.01	9.32	A	0.0031	132.79	10.32	A	0.0012	201.10	13.92
B	0.0030	233.18	16.47	B	0.0018	195.91	15.21	B	0.799	95.31	8.29	B	0.0091	126.82	11.59	B	0.104	71.26	5.26
C	0.0055	188.56	15.30	C	0.0054	194.33	15.16	C	0.0014	188.08	14.71	C	0.0028	161.13	15.43	C	0.0027	168.11	14.42
D	0.0060	116.98	12.95	D	0.075	92.92	8.64	D	0.001	163.12	14.03	D	0.1600	49.88	2.64	D	0.0031	124.38	12.95
E	0.1040	137.62	9.68	E	0.0018	177.58	14.25	E	0.0042	166.70	12.21	E	0.1500	54.75	4.15	E	0.004	181.31	1.20
F	0.0050	111.02	9.91	F	0.0031	117.92	11.81	F	0.224	31.66	1.16	F	0.0038	112.80	11.02	F	0.0057	146.91	8.88
G	0.0360	152.02	14.91	I	0.0104	116.03	14.33	I	0.0054	152.44	12.05	G	0.0053	132.73	8.19	G	0.038	32.42	14.32
H	0.0038	246.39	17.24	J	0.0028	158.85	15.32	J	0.0044	183.96	13.51	H	0.0850	73.09	5.52	H	0.021	90.31	10.13
F1	0.0050	144.66	13.65	F1	0.0034	122.13	12.62	F1	0.0025	156.23	8.12	F1	0.0025	155.74	13.78	F1	0.002	108.99	8.51
F2	0.0050	118.58	11.01	F2	0.0043	128.20	12.71	F2	0.0036	157.63	8.05	F2	0.007	112.06	8.25	F2	0.141	52.70	3.05
F3	0.0100	81.76	9.19	F3	0.0025	97.88	11.71	F3	0.0118	81.63	5.58	F3	0.0062	154.06	13.77	F3	0.0028	103.35	10.77
F4	0.1800	69.82	6.40	F4	0.17	52.28	2.39	F4	0.194	30.71	0.81	F4	0.139	68.53	4.88	F4	0.0099	127.29	7.81
F5	0.0300	95.61	9.56	F5	0.12	107.35	9.11	F5	0.0032	123.96	9.36	F5	0.007	103.51	7.37	F5	0.0013	123.94	12.63

Diameter of 50% (D_{50} : mm)
Natural Water Content (Wn : %)
Ignition Loss (Li : %)

Table 5.2.3-1(3) Diameter of 50%, Natural Water Content, Ignition Loss of Bottom Material

11th Monthly Survey				12th Monthly Survey			
	D_{50}	Wn	Li		D_{50}	Wn	Li
	mm	%	%		mm	%	%
A	0.0059	129.77	10.05	A	0.0031	145.94	12.84
B	0.086	91.50	7.17	B	0.0013	198.89	16.86
C	0.0026	188.60	11.89	C	0.0021	178.75	20.38
D	0.0041	147.40	12.92	D	0.0025	111.05	11.53
E	0.13	74.70	5.58	E	0.0031	206.52	14.79
F	0.0034	99.45	10.37	F	0.338	45.74	2.34
G	0.20	47.90	1.32	G	0.295	46.13	2.82
H	0.085	41.27	8.49	H	0.0041	111.37	11.64
F1	0.0017	207.24	14.22	F1	0.0036	151.58	12.18
F2	0.071	62.62	6.70	F2	0.017	114.41	8.57
F3	0.02	143.27	11.32	F3	0.0235	71.82	7.65
F4	0.189	45.92	2.18	F4	0.151	93.19	7.59
F5	0.0084	91.37	8.67	F5	0.0104	116.12	9.27

Diameter of 50%	(D_{50} : mm)
Natural Water Content	(Wn : %)
Ignition Loss	(Li : %)

5.2.4 Echo-Sounding in Narrow Area

Fig.5.2.4-1(1)-(6) show the Lateral Profile of the Channel in overlapping reults of echo-sounding in each stage and Fig.5.2.4-2(1)-(11) show the Longitudinal Profile of the Channel in overlapping results of echo-sounding.

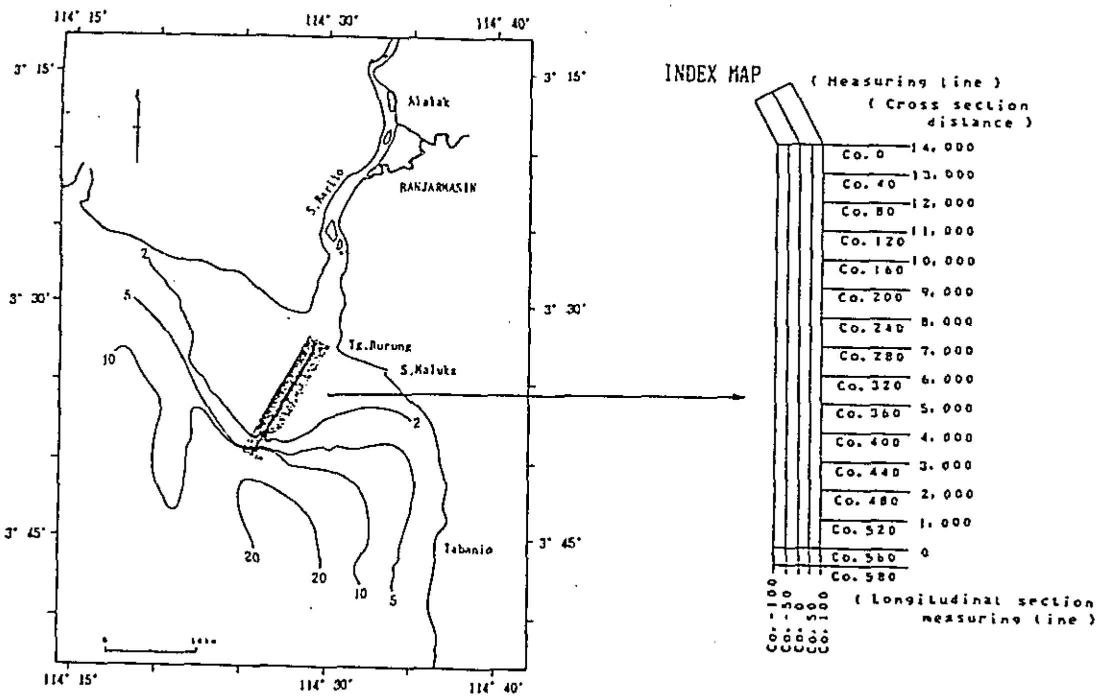
Table 5.2.4-1(1)-(8) show the change of soil volume every stage calculated from water volume.

A surface of seabed in the Access Channel is recorded as similar plane in the reflected planes by 210kHz and 33kHz of the 1st to 4th stage during dredging work conducting. (cf.Fig.5.2.4-2(1))
However, in the sounded record during the dredging work ceased from the 5th to 7th stage,two surfaces of the seabed appeared in the reflected planes.
On the refrected planes in the 5th stage, the two surfaces are scattered partly but in the 7th stage,these can be seen over most of area in the Access Channel.
There are some discrepancies of water depth between two reflected planes.The discrepancies show about 2-3 m and is presumed as a layer of fluid mud.(cf.Fig.5.2.4-4(1)-(2))
Examing the Change of muddy water volumes during dredging work conducting, they decreased to 34 x 10^4 m3 at 2nd stage and 82 x 10^4 m3 at 3rd stage.
The volume in at 4th stage was 7 x 10^4 m3 rather low comparing with 3rd stage.
On the contrary, during the dredging work ceased, the volume increased to 23 x 10^4 m3 in 5th stage and 27 x 10^4 m3 in 6th stage.
The volume in 7th stage, after two month from dredging ceased, increased greatly to 172 x 10^4 m3 and showed that big sedimentation of soil was carried out actively.
However the volume decreased after dreging work resumed and it of in 9th stage decreased to 43 x 10^4 m3.
The volumes from 10th to 12th stage decreased to less than 20 x 10^4 m3 every stage.(cf. Fig.5.2.4-3)

Echo-sounding Survey(Narrow Area) in each stage was conducted in the following Date

Stage	Date
1st stage(Frequency ; 210Khz) :	8 October -22 November 1988
2nd stage(Frequency ; 210Khz) :	23 November 1988 -13 January 1989
3rd stage(Frequency ; 210Khz) :	14 January -17 February 1989
4th stage(Frequency ; 210Khz) :	30 January -20 February 1989
5th stage(Frequency ; 210Khz) :	21 February - 8 March 1989
6th stage(Frequency ; 210Khz and 33Khz) :	8 March-17 April 1989
7th stage(Frequency ; 210Khz and 33Khz) :	26 April- 4 May 1989
8th satge(Frequency ; 210Khz) :	25 May - 3 June 1989
9th stage(Frequency ; 210Khz) :	16 June -23 June 1989
10th stage(Frequency ; 210Khz) :	16 July -22 July 1989
11th stage(Frequency ; 210Khz) :	21 July - 1 August 1989
12th stage(Frequency ; 210Khz) :	7 August -13 August 1989

(Dredge cease period : February 28 ~ May 24, 1989)



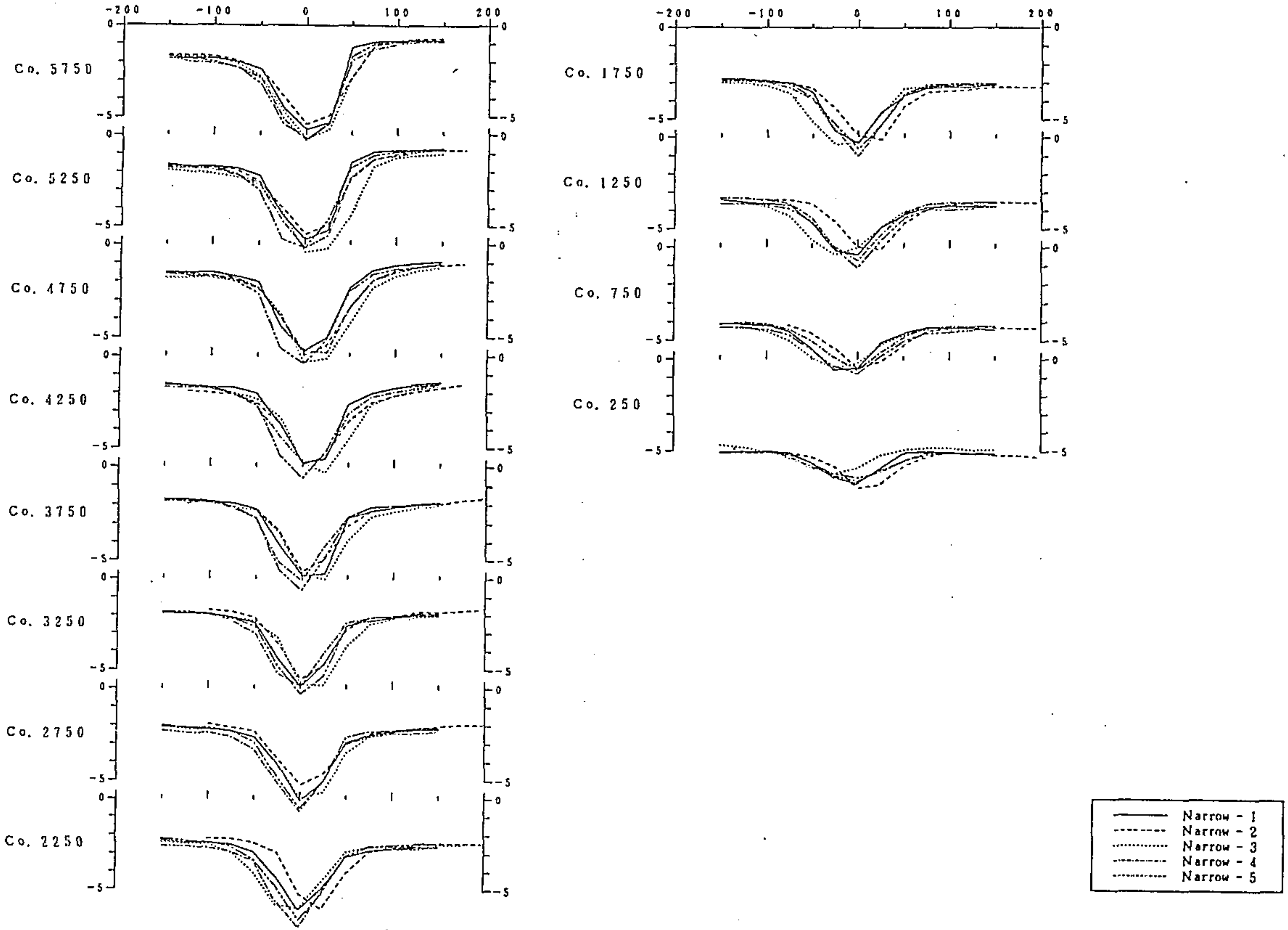


Fig. 5.2.4-1(1) Lateral Profile of the Channel

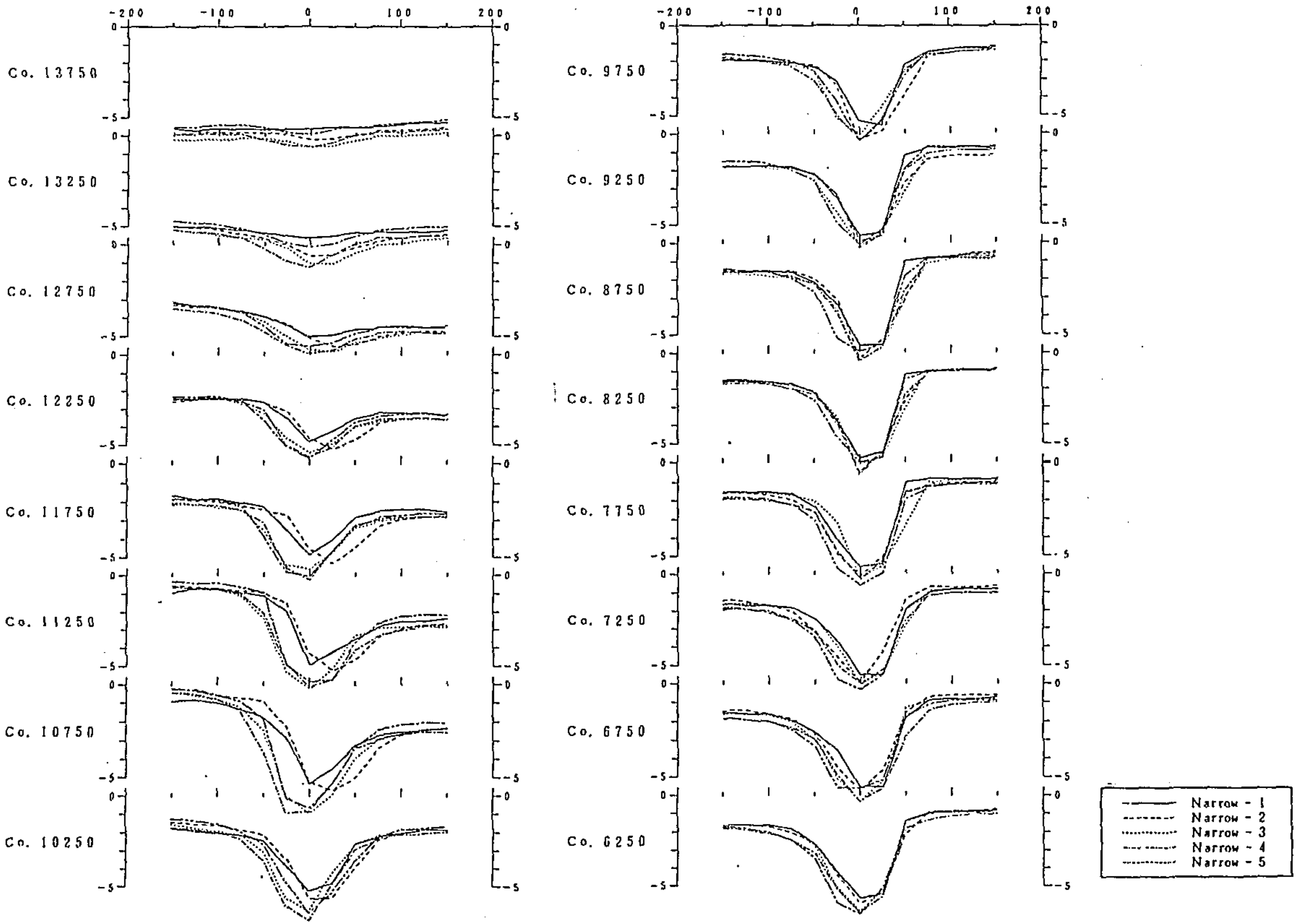


Fig. 5.2.4-1(2) Lateral Profile of the Channel

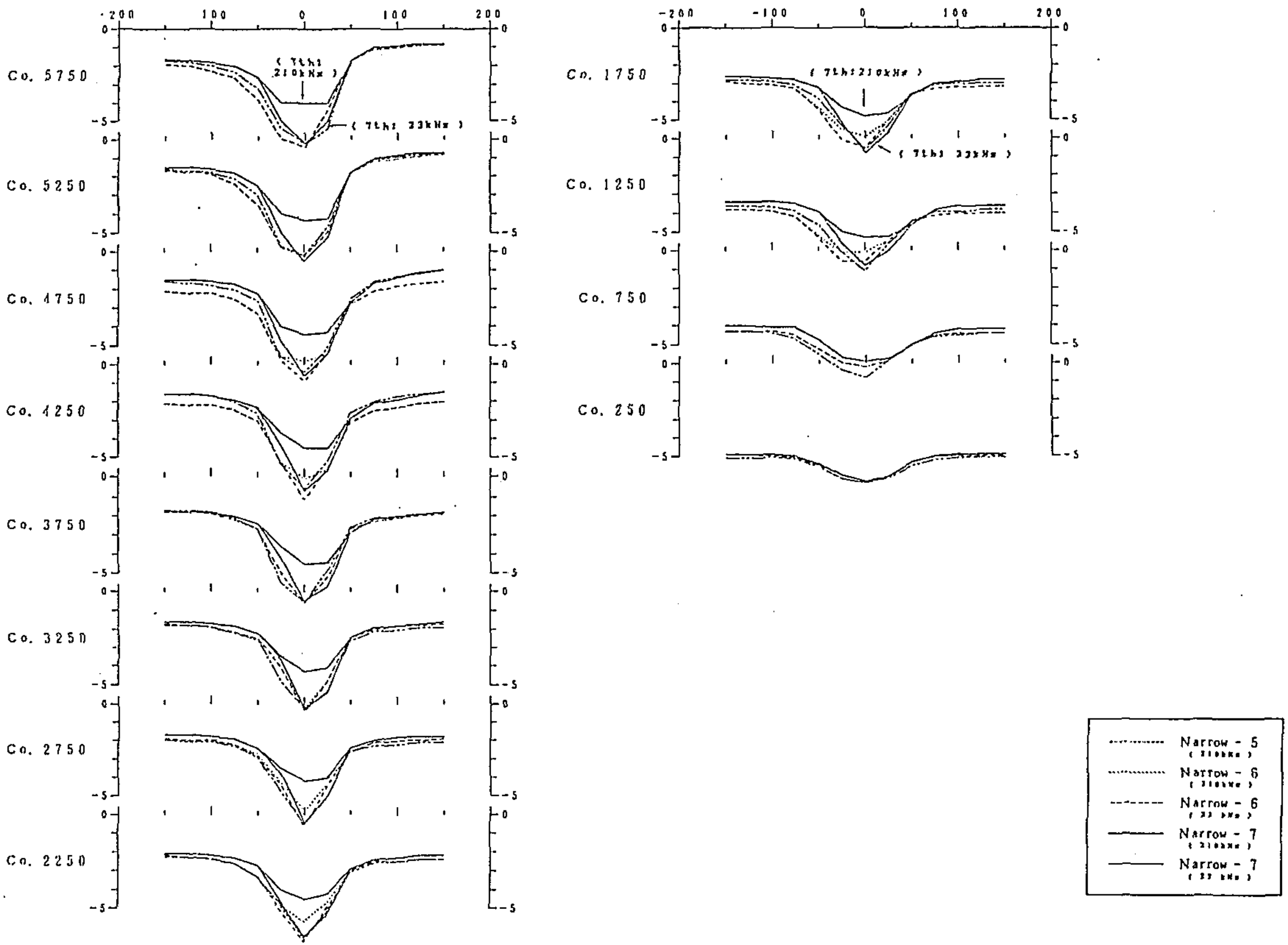


Fig. 5.2.4-1(3) Lateral Profile of the Channel

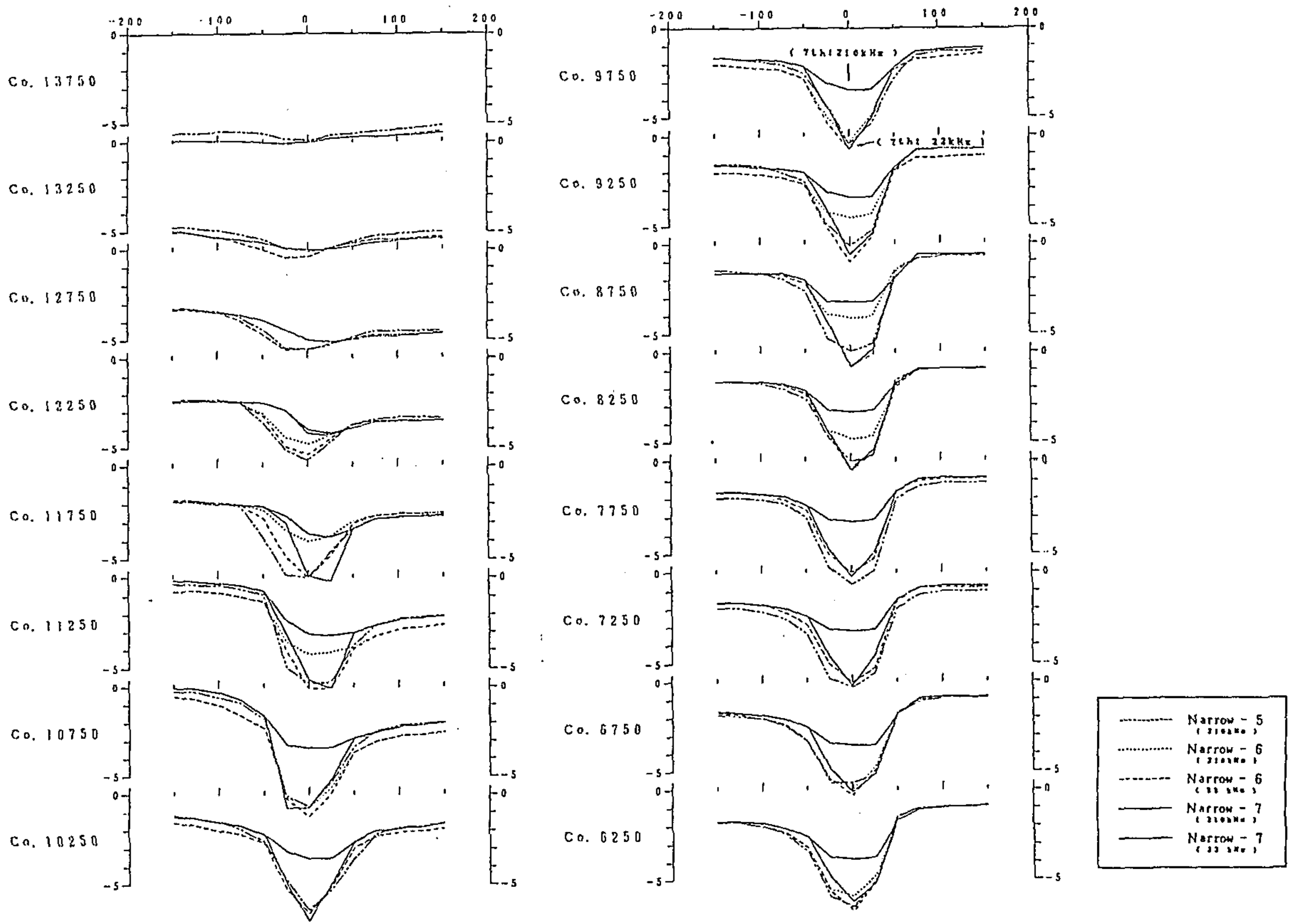


Fig. 5.2.4-1(4) Lateral Profile of the Channel

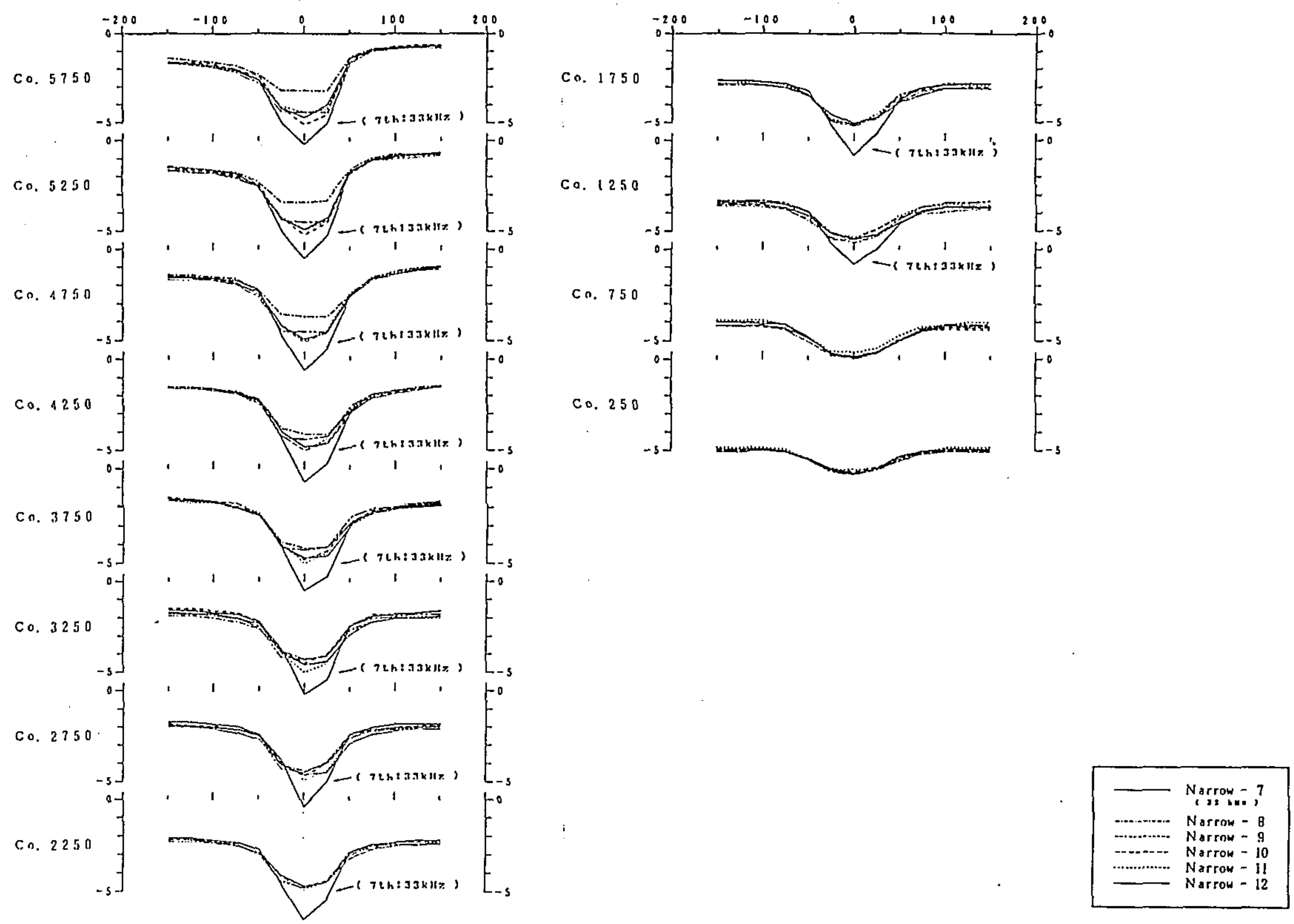


Fig. 5.2.4-1(5) Lateral Profile of the Channel

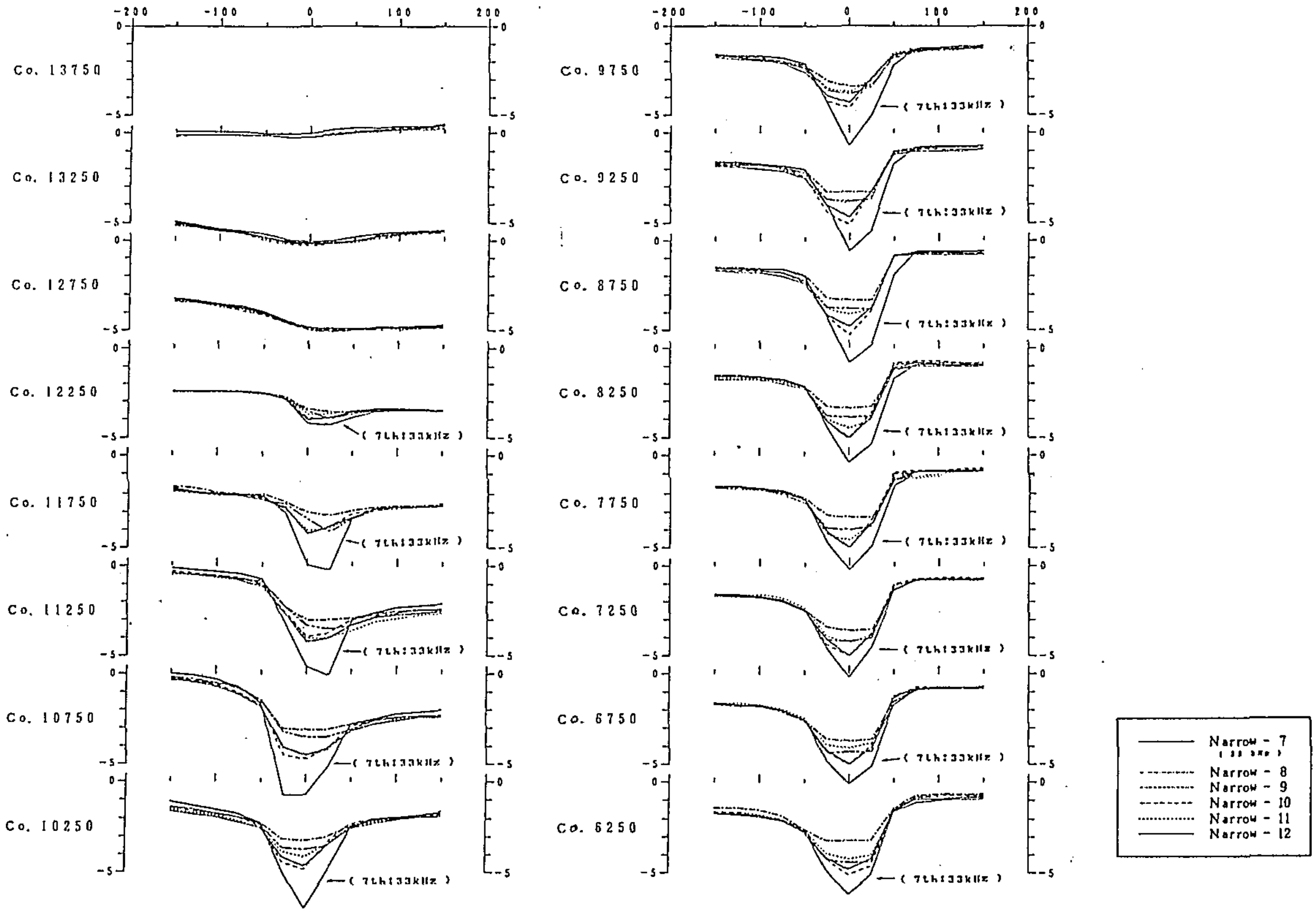


Fig. 5.2.4-1(6) Lateral Profile of the Channel

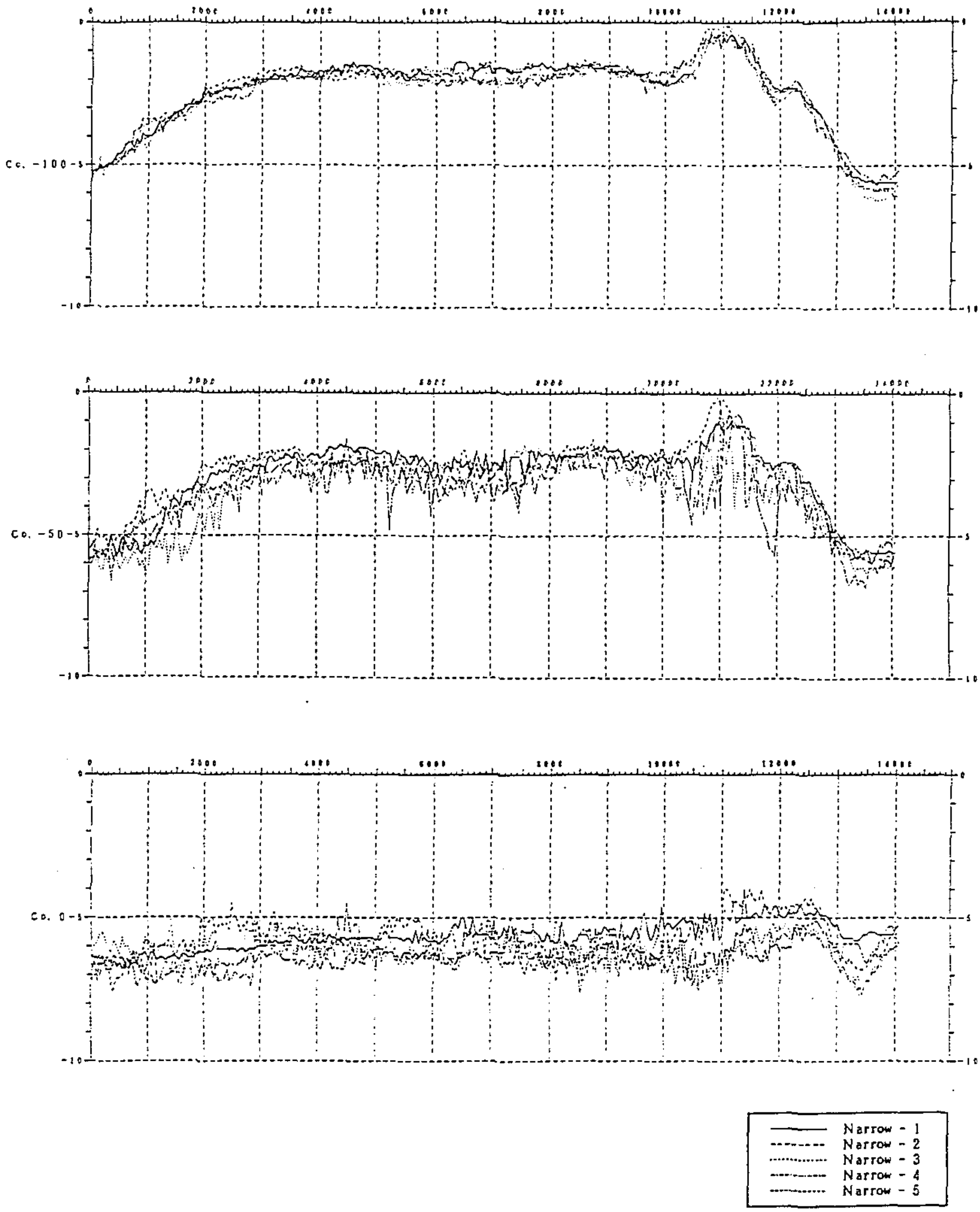


Fig. 5.2.4-2(1) Longitudinal Profile of the Channel

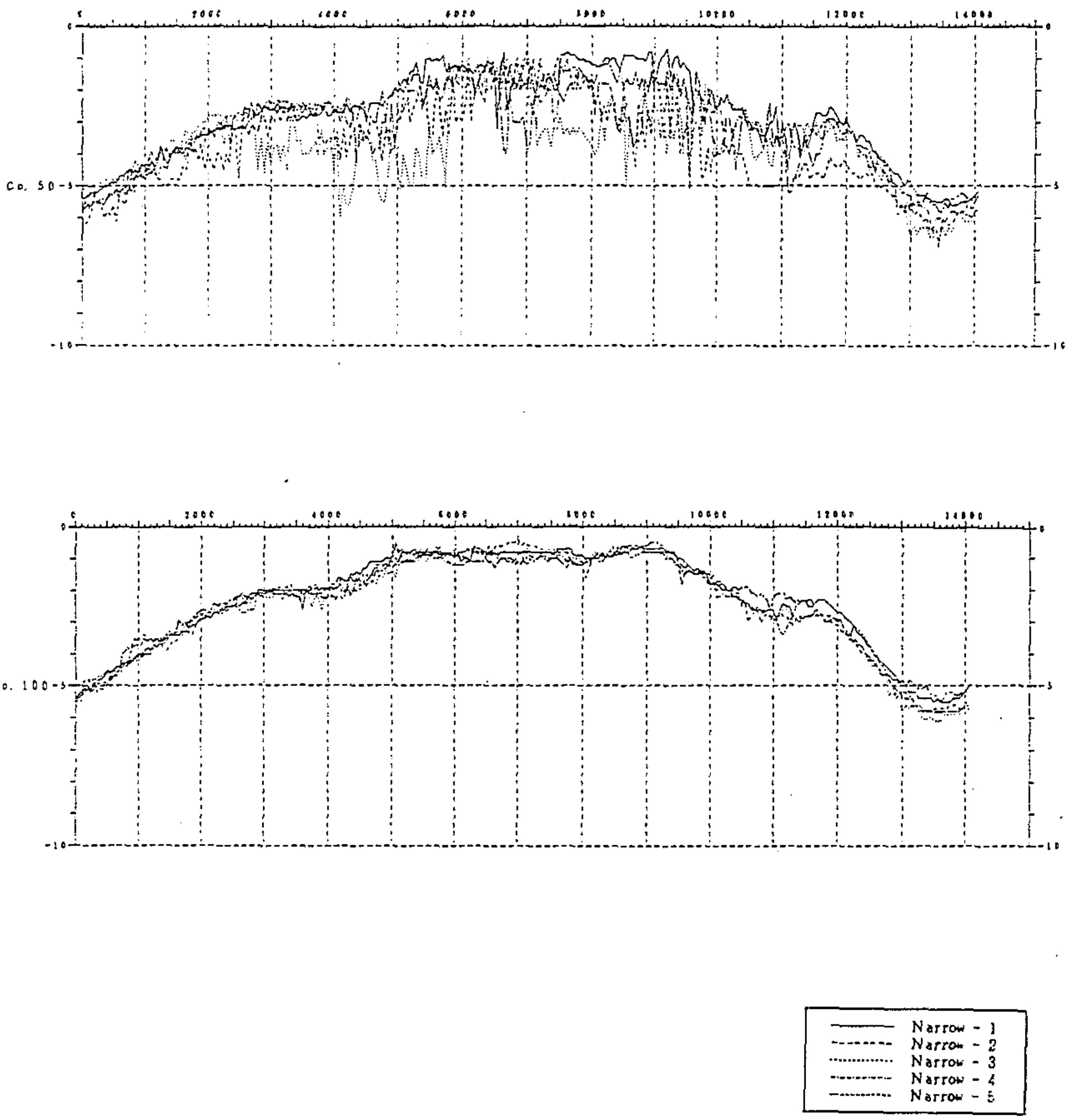


Fig. 5.2.4-2(2) Longitudinal Profile of the Channel

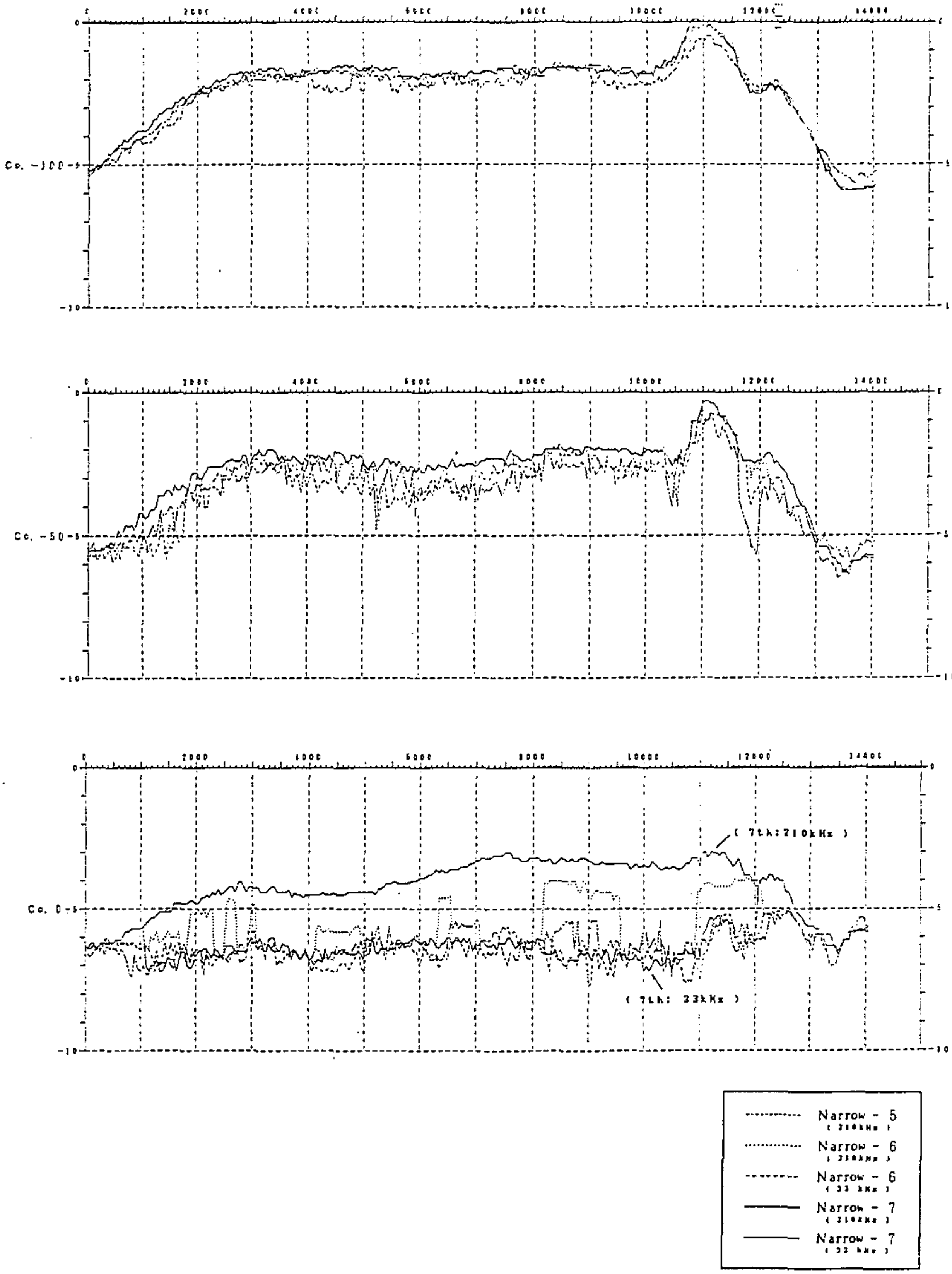


Fig. 5.2.4-2(3) Longitudinal Profile of the Channel

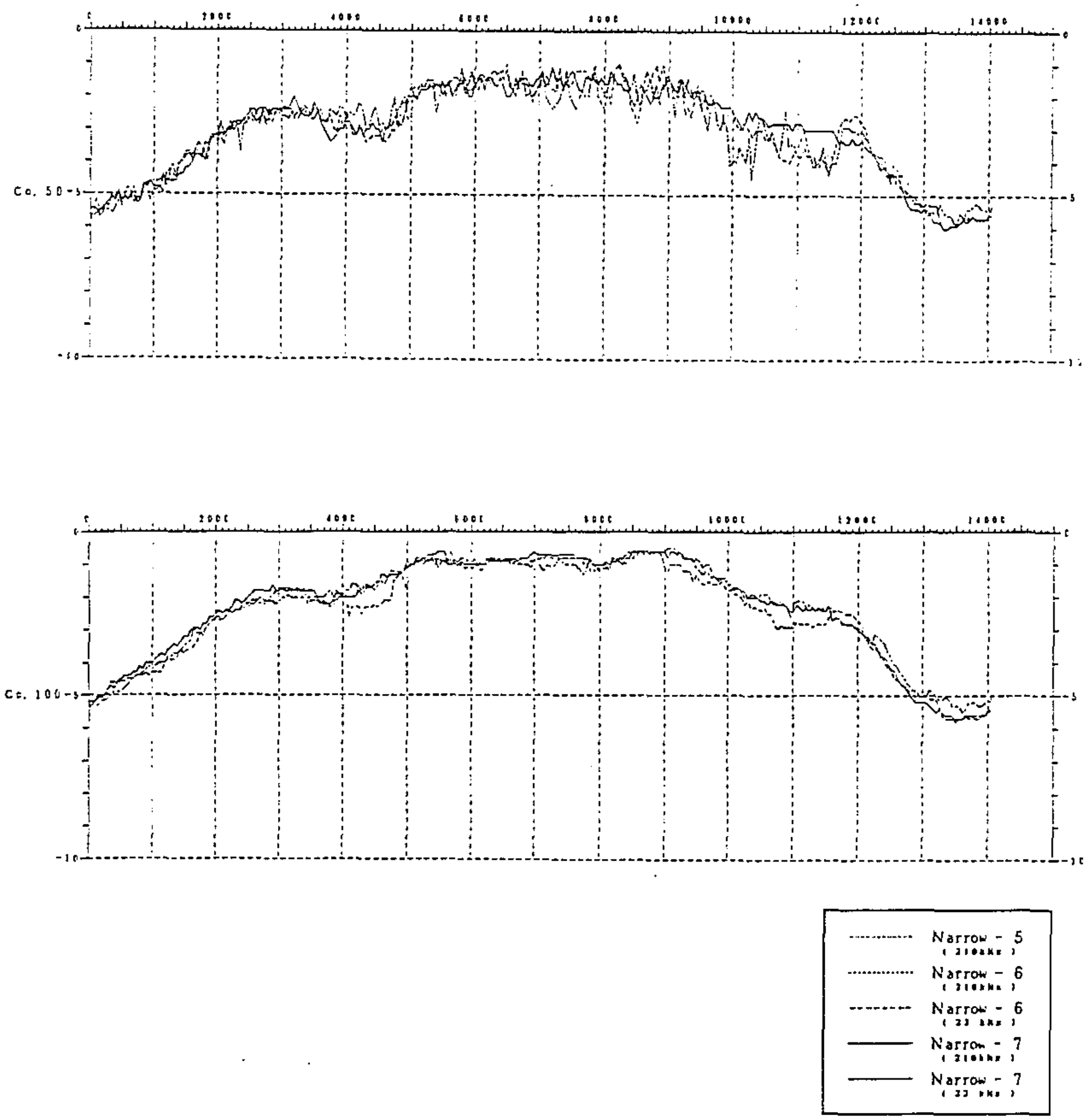


Fig. 5.2.4-2(4) Longitudinal Profile of the Channel

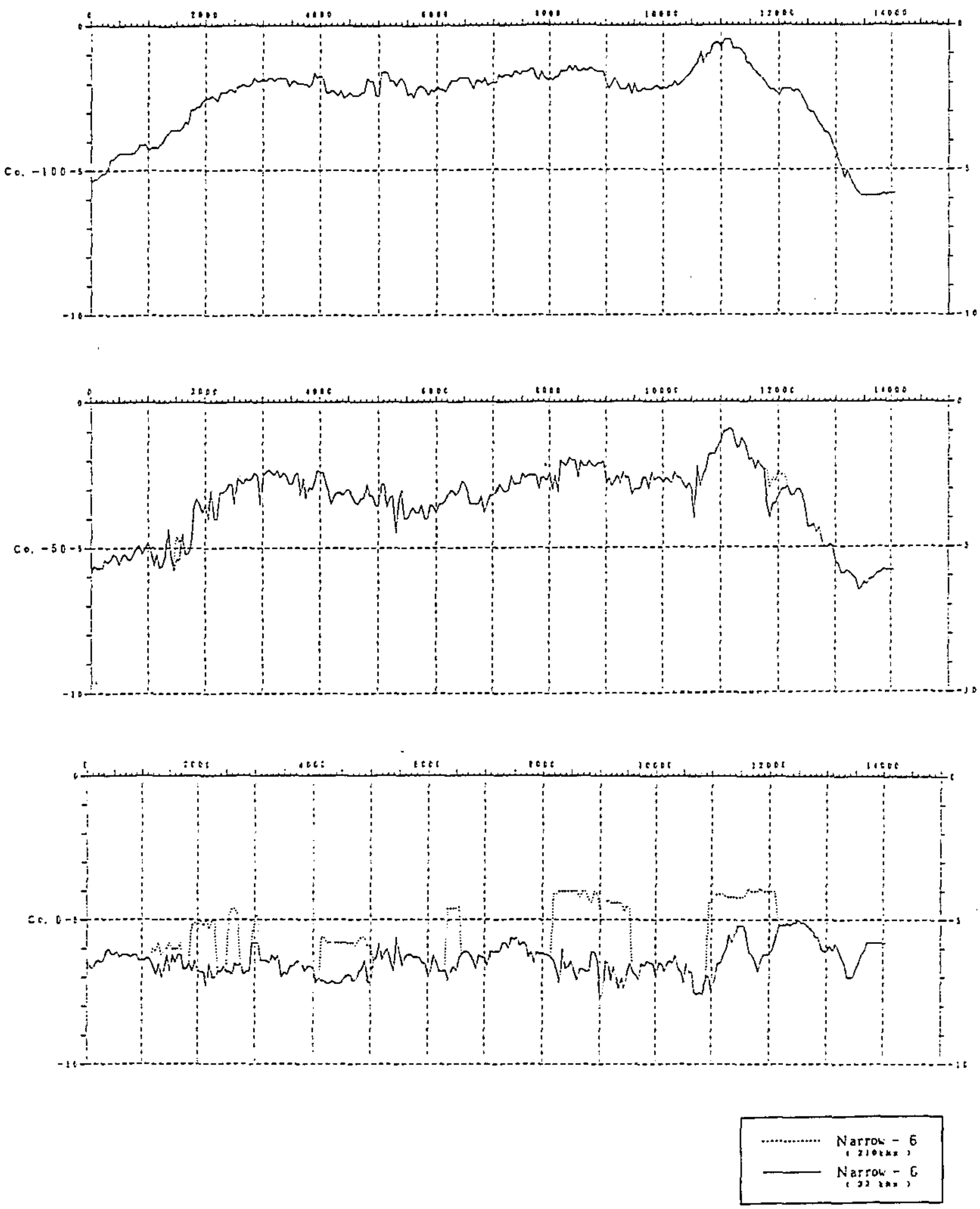


Fig. 5.2.4-2(5) Longitudinal Profile of the Channel

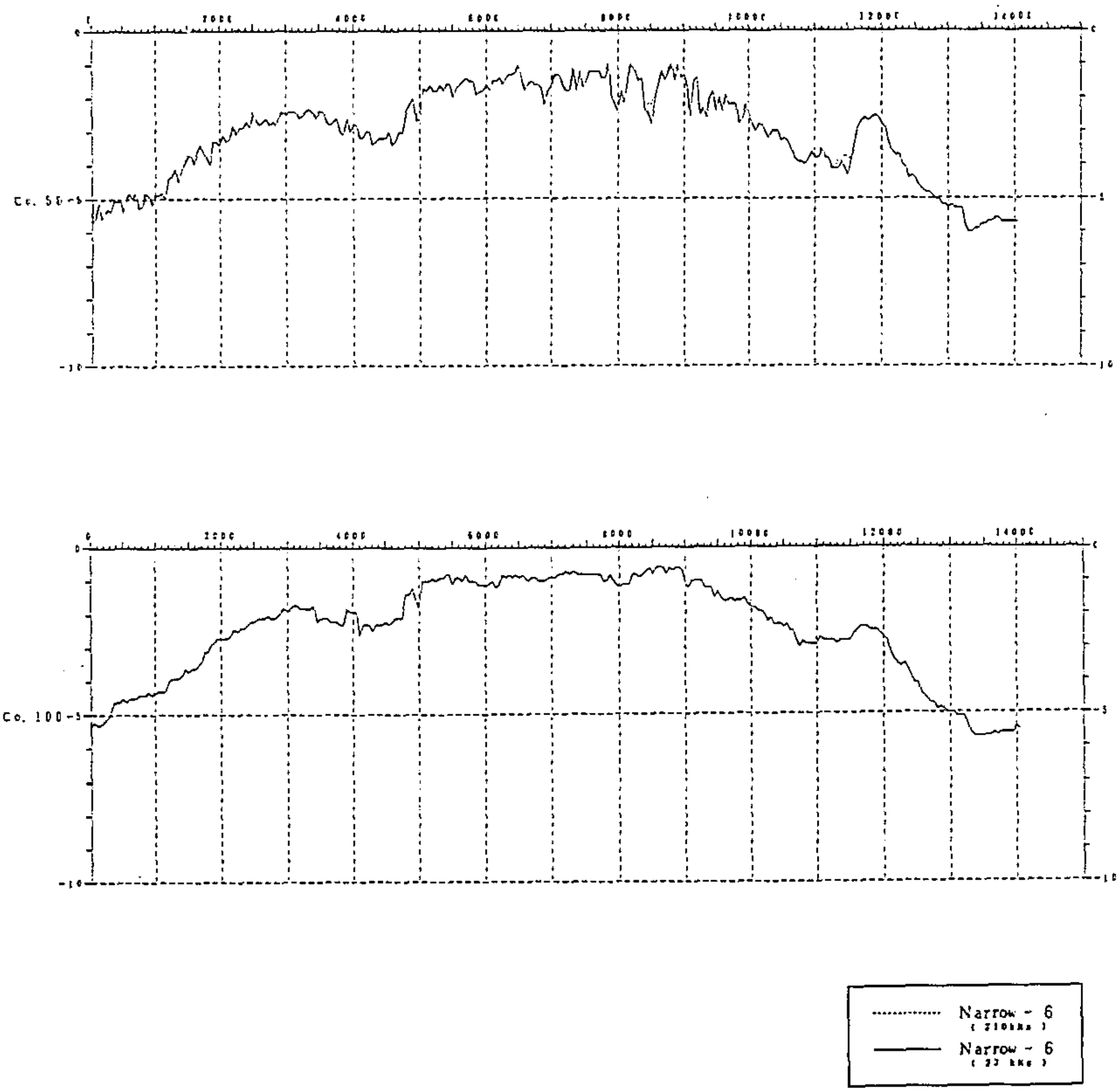


Fig. 5.2.4-2(6) Longitudinal Profile of the Channel

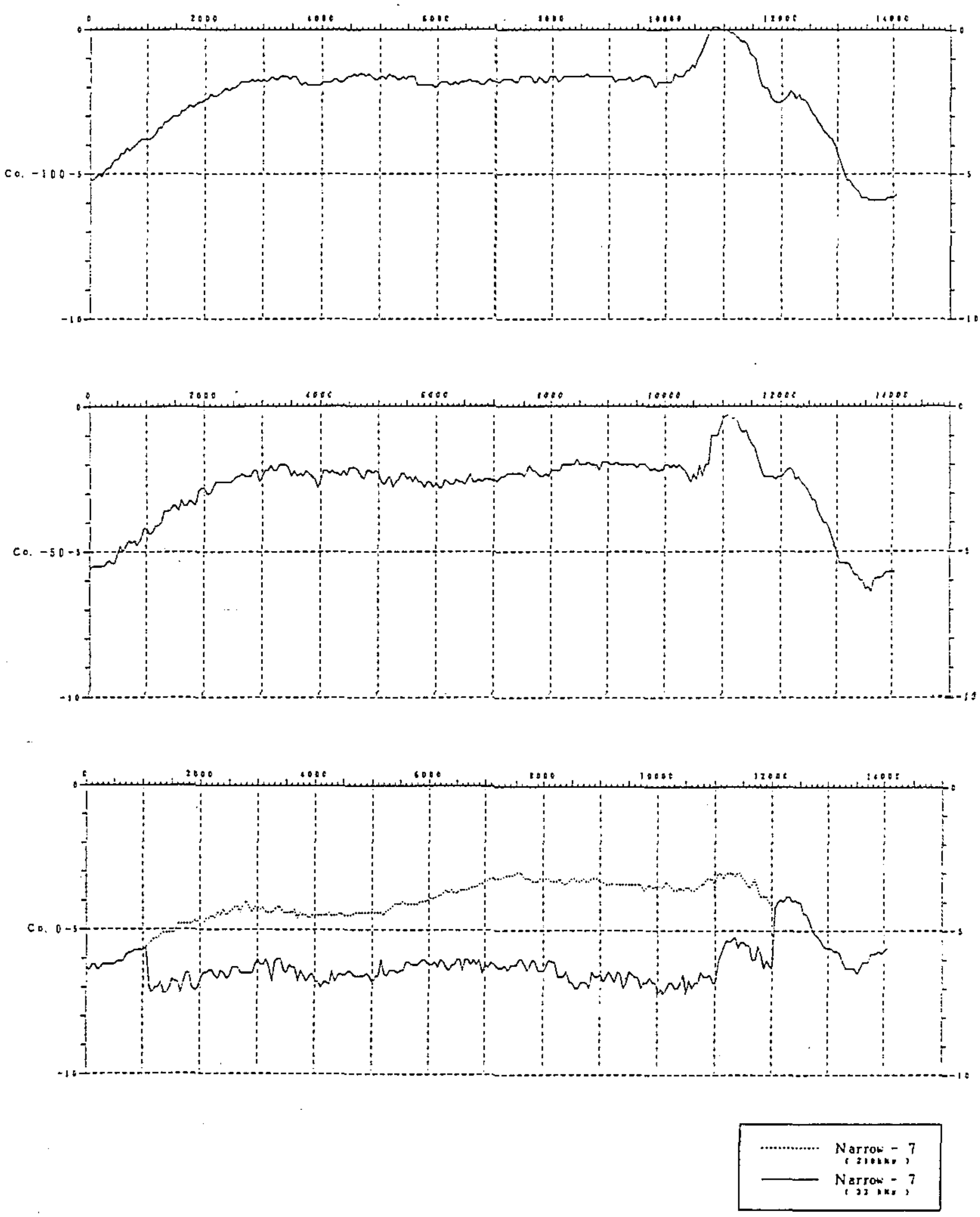


Fig. 5.2.4-2(7) Longitudinal Profile of the Channel

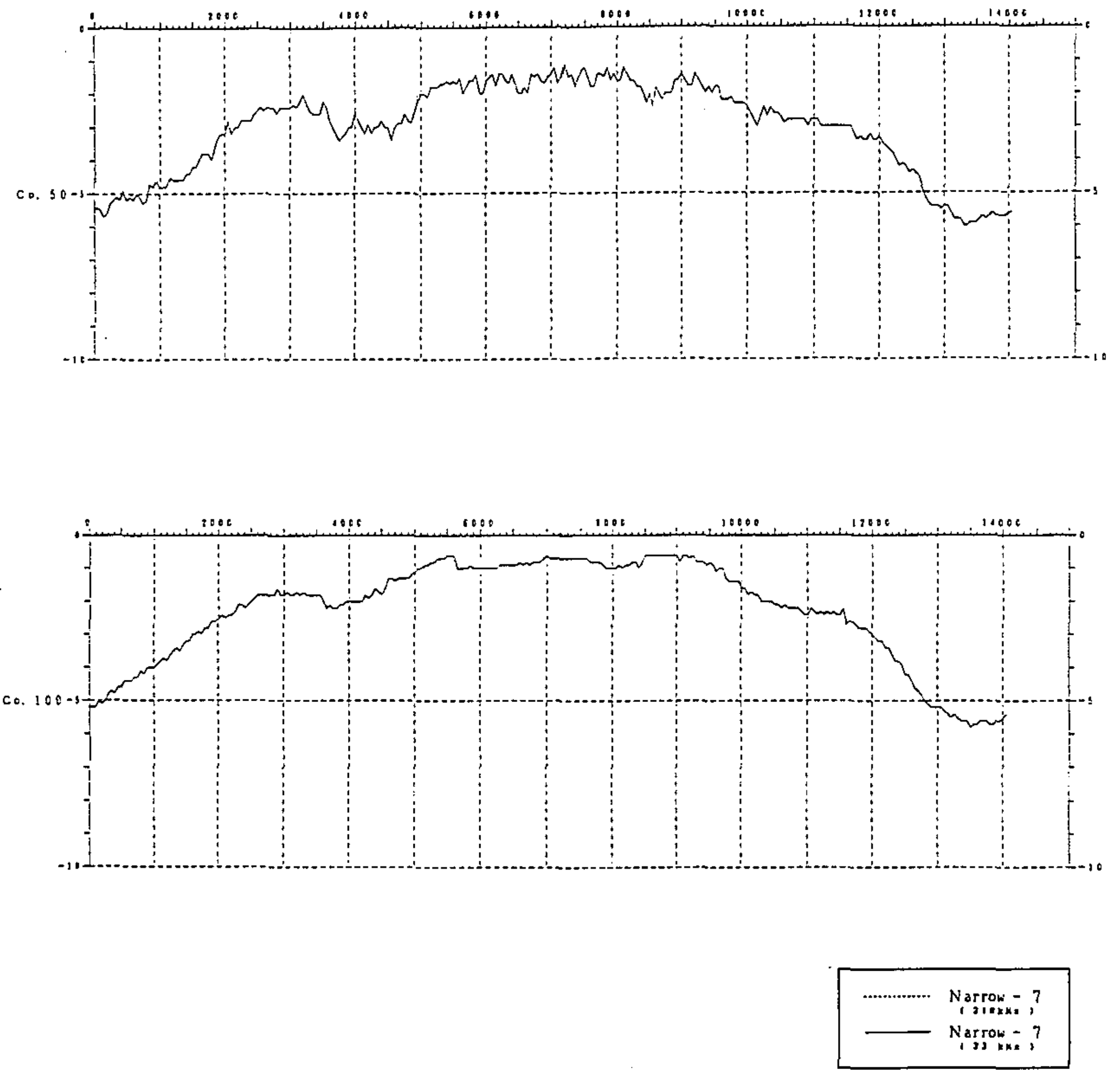


Fig. 5.2.4-2(8) Longitudinal Profile of the Channel

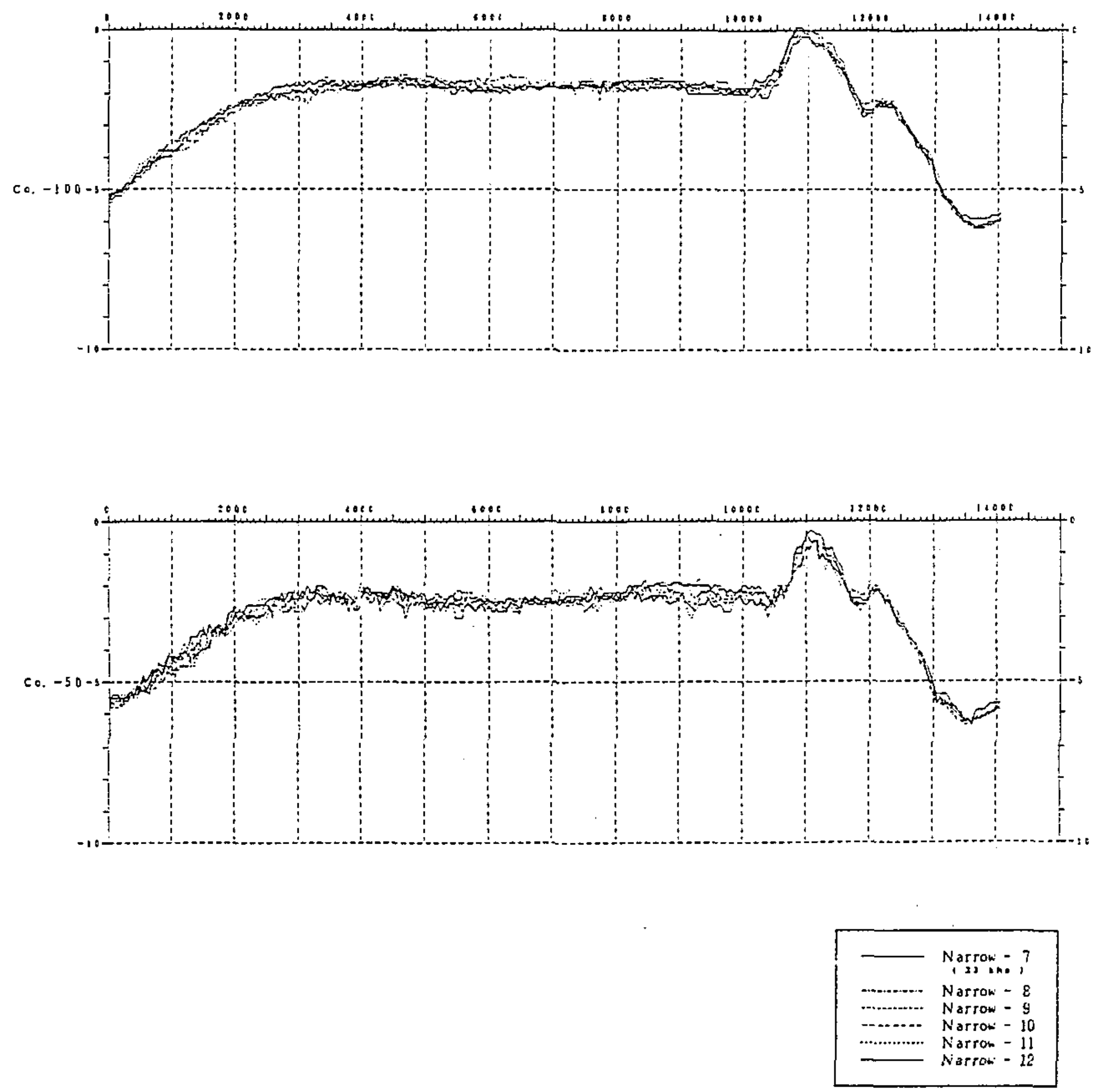


Fig. 5.2.4-2(9) Longitudinal Profile of the Channel

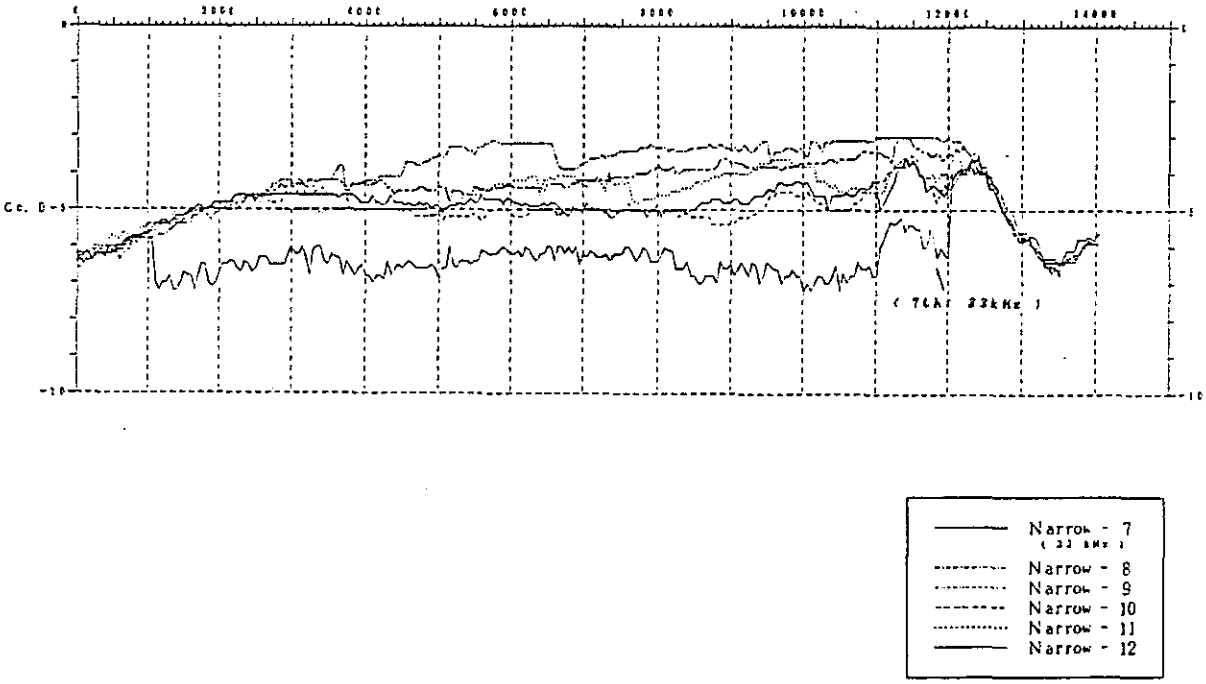


Fig. 5.2.4-2(10) Longitudinal Profile of the Channel

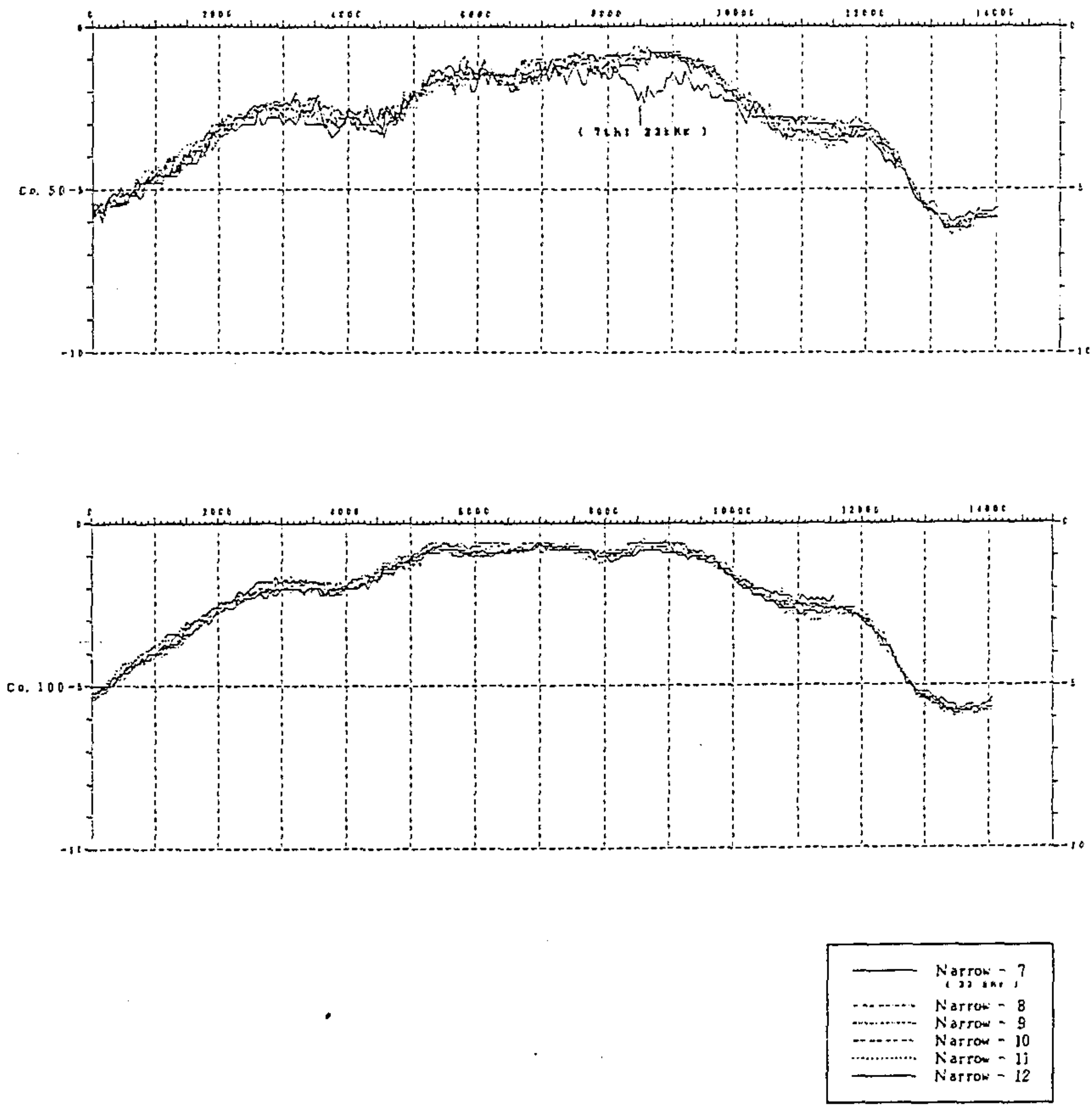


Fig. 5.2.4-2(11) Longitudinal Profile of the Channel

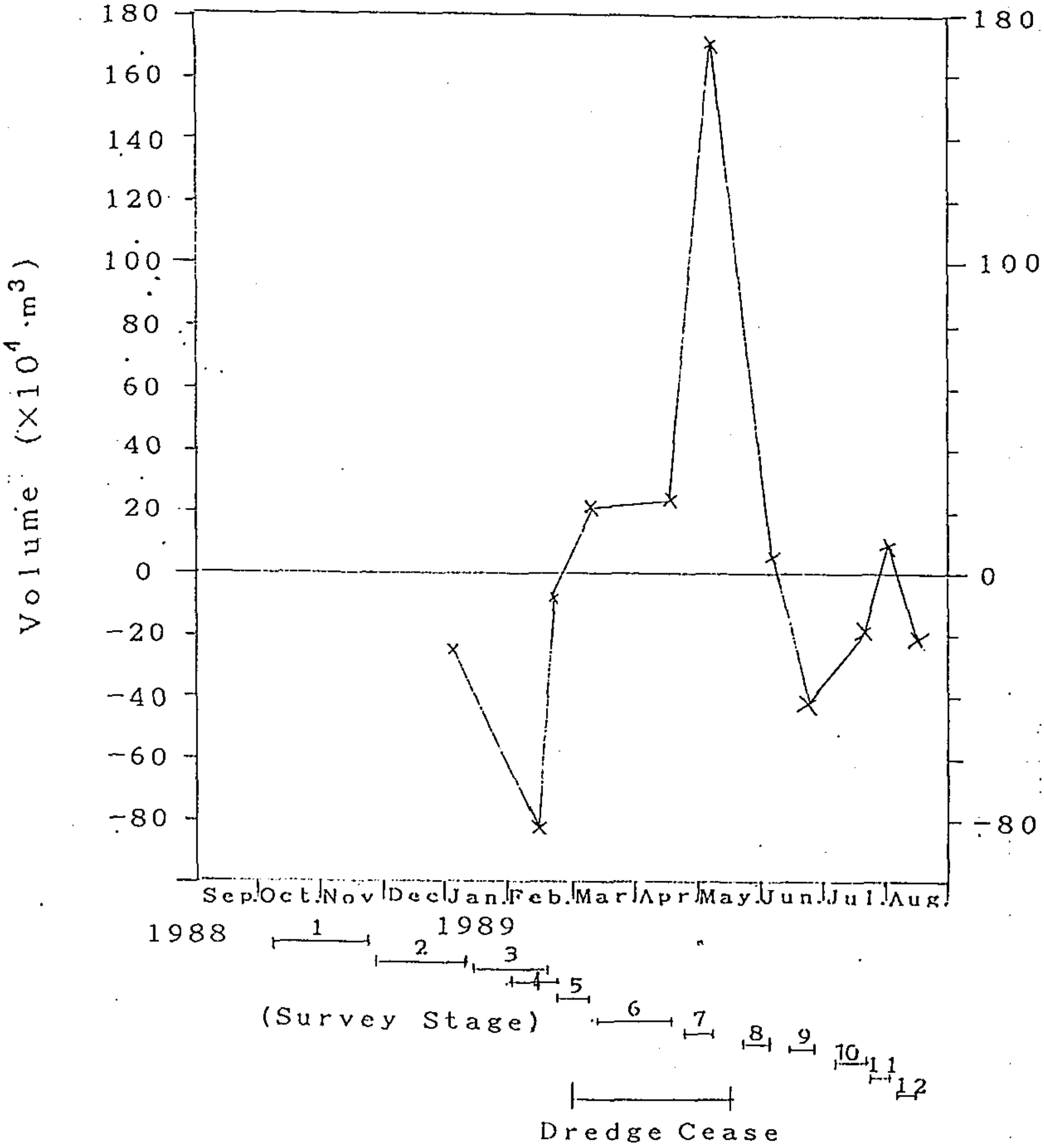
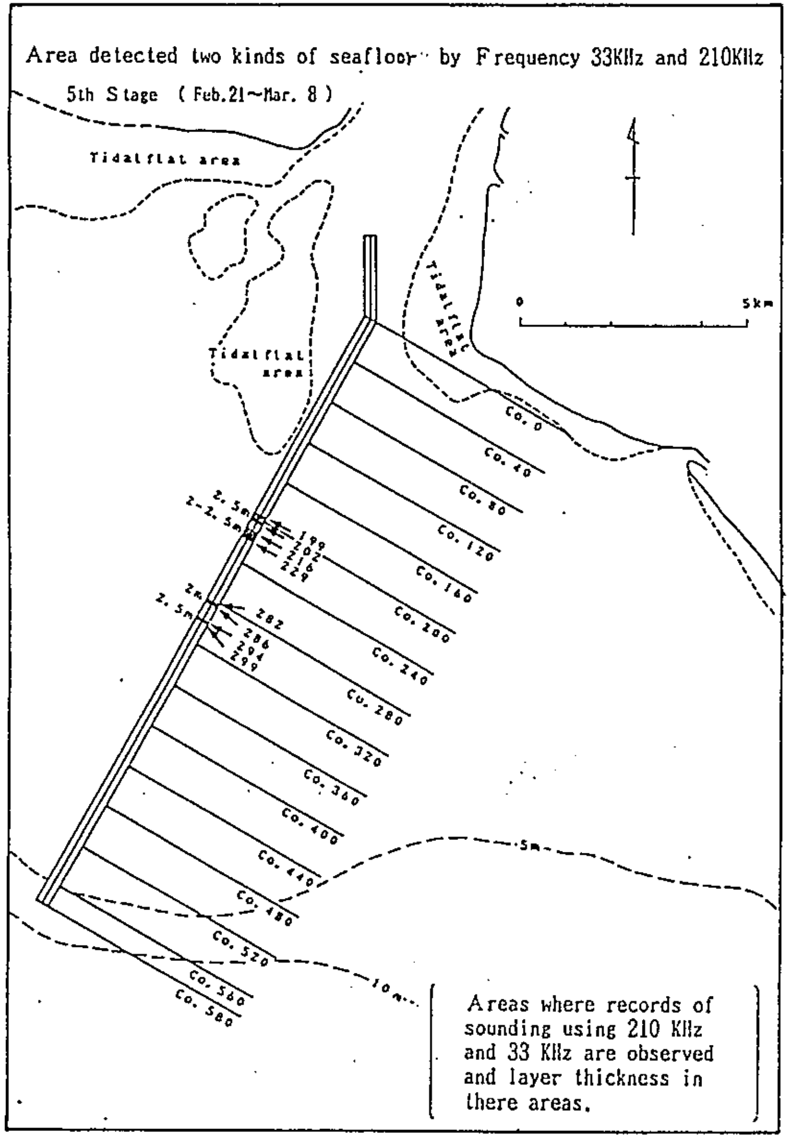


Fig. 5. 2. 4-3 Change of Water Volume by Stage
based on 210KHz



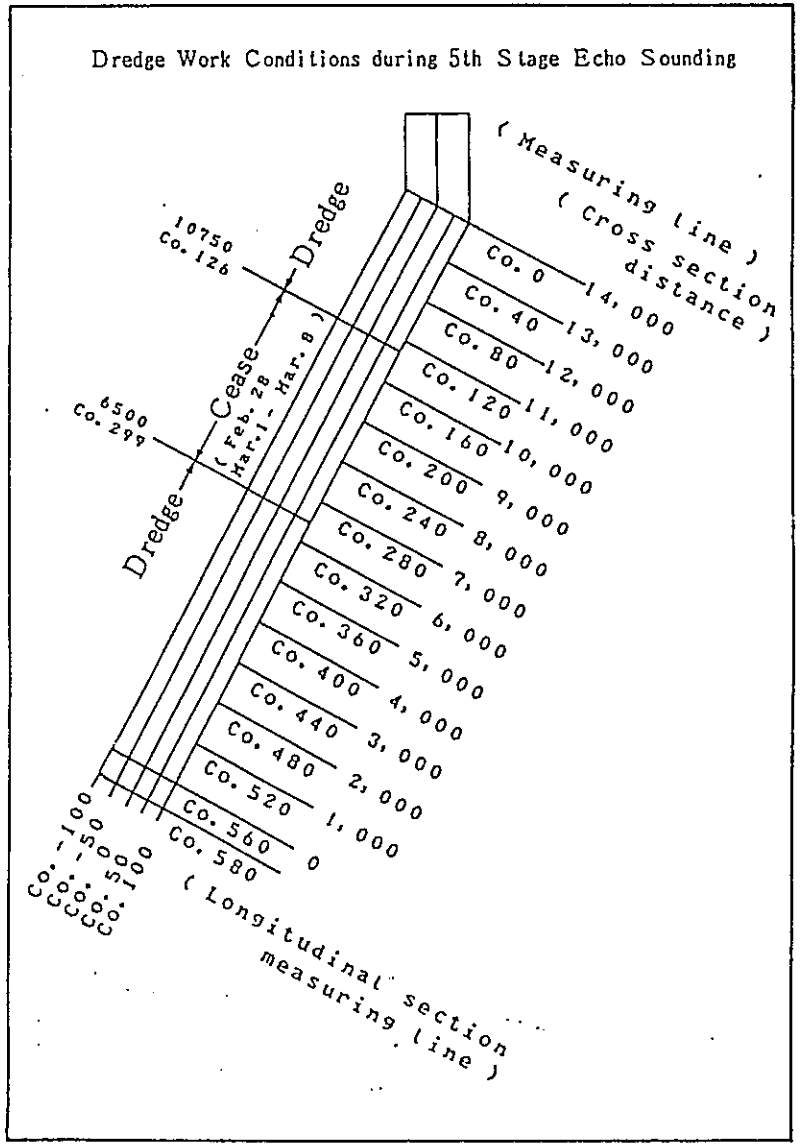


Fig. 5.2.4-4(1). Relation between Dredge Work and Result of 5th Stage Echo-Sounding in Narrow Area

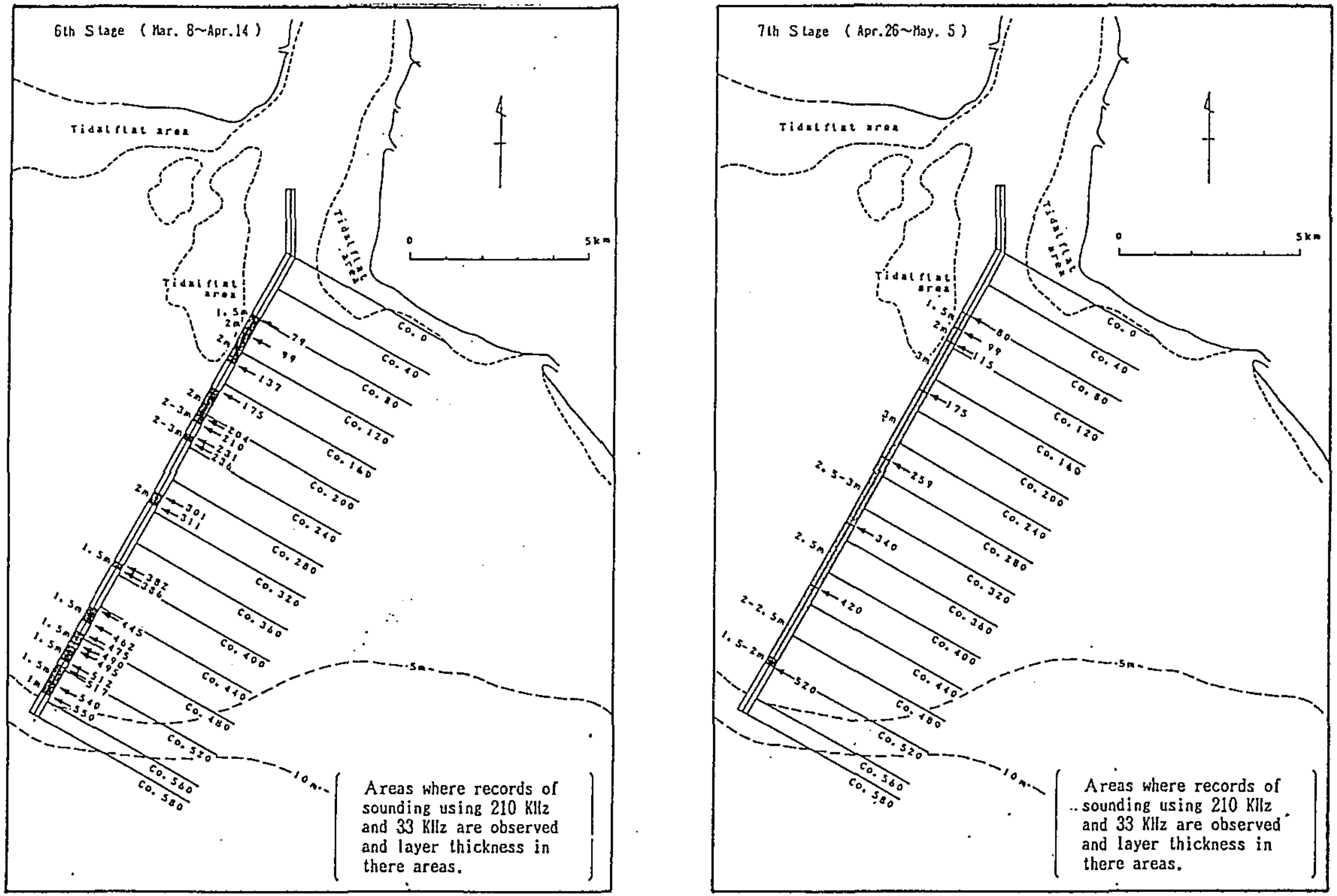


Fig. 5.2.4.-4(2) Area Detected Two Kinds of Seabed by 33kHz and 210kHz

Table 5.2.4-1(1) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-1	Narrow-2	
0			
	562102	510624	51478
500			
	518068	505838	12230
1000			
	470681	447840	22841
1500			
	415056	421250	-6194
2000			
	365738	352556	13182
2500			
	345738	317556	28182
3000			
	330568	304261	26307
3500			
	333977	315454	18523
4000			
	315113	344829	-29716
4500			
	299034	330170	-31136
5000			
	287159	297272	-10113
5500			
	291307	296647	-5340
6000			
	288579	303977	-15398
6500			
	285852	280795	5057
7000			
	288011	287613	398
7500			
	274659	306591	-31932
8000			
	278863	308807	-29944
8500			
	264602	289392	-24790
9000			
	271363	309829	-38466
9500			
	294261	339545	-45284
10000			
	312670	333579	-20909
10500			
	289886	309170	-19284
11000			
	261875	280704	-18829
11500			
	301079	341079	-40000
12000			
	338693	369034	-30341
12500			
	432272	463011	-30739
13000			
	538579	591022	-52443
13500			
	553806	590397	-36591
14000			
TOTAL	9809592	10148845	-339253

Distance	Water Volume		Increase Decrease
	Narrow-2	Narrow-3	
0			
	510624	540284	-29660
500			
	505838	529431	-23593
1000			
	447840	484715	-36875
1500			
	421250	444659	-23409
2000			
	352556	389091	-36535
2500			
	317556	361591	-44035
3000			
	304261	345852	-41591
3500			
	315454	353863	-38409
4000			
	344829	357897	-13068
4500			
	330170	358579	-28409
5000			
	297272	368295	-71023
5500			
	296647	333181	-36534
6000			
	303977	309375	-5398
6500			
	280795	312386	-31591
7000			
	287613	305738	-18125
7500			
	306591	303068	3523
8000			
	308807	309886	-1079
8500			
	289392	314716	-25324
9000			
	309829	326534	-16705
9500			
	339545	329943	9602
10000			
	333579	348863	-15284
10500			
	309170	386818	-77648
11000			
	280704	349716	-69012
11500			
	341079	380340	-39261
12000			
	369034	394261	-25227
12500			
	463011	487443	-24432
13000			
	591022	620113	-29091
13500			
	590397	623749	-33352
14000			
TOTAL	10148845	10970388	-821543

Table 5.2.4-1(2) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-3	Narrow-4	
0	540284	570624	-30340
500	529431	511193	18238
1000	484715	464659	20056
1500	444659	437784	6875
2000	389091	408465	-19374
2500	361591	384261	-22670
3000	345852	335795	10057
3500	353863	337897	15966
4000	357897	345056	12841
4500	358579	330284	28295
5000	368295	329375	38920
5500	333181	332613	568
6000	309375	341761	-32386
6500	312386	346022	-33636
7000	305738	336250	-30512
7500	303068	314829	-11761
8000	309886	315795	-5909
8500	314716	306931	7785
9000	326534	290795	35739
9500	329943	346193	-16250
10000	348863	386761	-37898
10500	386818	398693	-11875
11000	349716	362670	-12954
11500	380340	381307	-967
12000	394261	396931	-2670
12500	487443	501477	-14034
13000	620113	617556	2557
13500	623749	611647	12102
14000			
TOTAL	10970388	11043626	-73238

Distance	Water Volume		Increase Decrease
	Narrow-4	Narrow-5	
0	570624	565227	5397
500	511193	539090	-27897
1000	464659	492556	-27897
1500	437784	422386	15398
2000	408465	382045	26420
2500	384261	355852	28409
3000	335795	349886	-14091
3500	337897	353466	-15569
4000	345056	351591	-6535
4500	330284	341761	-11477
5000	329375	325113	4262
5500	332613	330909	1704
6000	341761	338750	3011
6500	346022	328863	17159
7000	336250	350966	-14716
7500	314829	351647	-36818
8000	315795	310738	5057
8500	306931	309886	-2955
9000	290795	305227	-14432
9500	346193	329091	17102
10000	386761	352273	34488
10500	398693	346119	52574
11000	362670	320079	42591
11500	381307	385341	-4034
12000	396931	393181	3750
12500	501477	470454	31023
13000	617556	552045	65511
13500	611647	555227	56420
14000			
TOTAL	11043626	10809768	233858

Table 5.2.4-1(3) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-5 (210KHz)	Narrow-6 (210KHz)	
0	565227	556874	8353
500	539090	522102	16988
1000	492556	491988	568
1500	422386	425227	-2841
2000	382045	362613	19432
2500	355852	326818	29034
3000	349886	324716	25170
3500	353466	359375	-5909
4000	351591	379034	-27443
4500	341761	367613	-25852
5000	325113	340795	-15682
5500	330909	344772	-13863
6000	338750	320341	18409
6500	328863	322670	6193
7000	350966	309091	41875
7500	351647	307216	44431
8000	310738	274204	36534
8500	309886	242500	67386
9000	305227	284147	21080
9500	329091	336136	-7045
10000	352273	365625	-13352
10500	346119	381761	-35642
11000	320079	286306	33773
11500	385341	289716	95625
12000	393181	366022	27159
12500	470454	481534	-11080
13000	552045	583977	-31932
13500	555227	586704	-31477
14000			
TOTAL	10809768	10539876	269892

Distance	Water Volume		Increase Decrease
	Narrow-6 (210KHz)	Narrow-7 (210KHz)	
0	556874	548920	7954
500	522102	495738	26364
1000	491988	433579	58409
1500	425227	367386	57841
2000	362613	316022	46591
2500	326818	278693	48125
3000	324716	272954	51762
3500	359375	299034	60341
4000	379034	296307	82727
4500	367613	282102	85511
5000	340795	261761	79034
5500	344772	259318	85454
6000	320341	248920	71421
6500	322670	235966	86704
7000	309091	213068	96023
7500	307216	214716	92500
8000	274204	217386	56818
8500	242500	210852	31648
9000	284147	216363	67784
9500	336136	233522	102614
10000	365625	254772	110853
10500	381761	236477	145284
11000	286306	206307	79999
11500	289716	281761	7955
12000	366022	329488	36534
12500	481534	451250	30284
13000	583977	570681	13296
13500	586704	585113	1591
14000			
TOTAL	10539876	8818457	1721419

Table 5.2.4-1(4) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-7 (210KHz)	Narrow-8 (210KHz)	
0	548920	559318	-10398
500	495738	506136	-10398
1000	433579	458522	-24943
1500	367386	392386	-25000
2000	316022	337613	-21591
2500	278693	304147	-25454
3000	272954	296761	-23807
3500	299034	293693	5341
4000	296307	278863	17444
4500	282102	252613	29489
5000	261761	223068	38693
5500	259318	212216	47102
6000	248920	211136	37784
6500	235966	236306	-340
7000	213068	226988	-13920
7500	214716	215341	-625
8000	217386	209488	7898
8500	210852	199091	11761
9000	216363	207386	8977
9500	233522	234772	-1250
10000	254772	246761	8011
10500	236477	227897	8580
11000	206307	209545	-3238
11500	281761	256534	25227
12000	329488	308068	21420
12500	451250	451534	-284
13000	570681	593806	-23125
13500	585113	607215	-22102
14000			
TOTAL	8818457	8757206	61251

Distance	Water Volume		Increase Decrease
	Narrow-8 (210KHz)	Narrow-9 (210KHz)	
0	559318	556136	3182
500	506136	493579	12557
1000	458522	426818	31704
1500	392386	376647	15739
2000	337613	336193	1420
2500	304147	304602	-455
3000	296761	290909	5852
3500	293693	291818	1875
4000	278863	293011	-14148
4500	252613	294773	-42160
5000	223068	279432	-56364
5500	212216	272841	-60625
6000	211136	269602	-58466
6500	236306	261193	-24887
7000	226988	251534	-24546
7500	215341	241363	-26022
8000	209488	231988	-22500
8500	199091	225170	-26079
9000	207386	234091	-26705
9500	234772	248693	-13921
10000	246761	267443	-20682
10500	227897	243977	-16080
11000	209545	228238	-18693
11500	256534	290284	-33750
12000	308068	319318	-11250
12500	451534	462272	-10738
13000	593806	591250	2556
13500	607215	605511	1704
14000			
TOTAL	8757206	9188684	-431478

Table 5.2.4-1(5) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-9 (210KHz)	Narrow-10 (210KHz)	
0	556136	550284	5852
500	493579	503295	-9716
1000	426818	443749	-16931
1500	376647	383181	-6534
2000	336193	324715	11478
2500	304602	298011	6591
3000	290909	275397	15512
3500	291818	299318	-7500
4000	293011	305795	-12784
4500	294773	300000	-5227
5000	279432	282159	-2727
5500	272841	273295	-454
6000	269602	274432	-4830
6500	261193	263238	-2045
7000	251534	255738	-4204
7500	241363	246932	-5569
8000	231988	243863	-11875
8500	225170	254772	-29602
9000	234091	255000	-20909
9500	248693	257500	-8807
10000	267443	288068	-20625
10500	243977	287329	-43352
11000	228238	236988	-8750
11500	290284	292443	-2159
12000	319318	316477	2841
12500	462272	460795	1477
13000	591250	593465	-2215
13500	605511	602954	2557
14000			
TOTAL	9188684	9369195	-180511

Distance	Water Volume		Increase Decrease
	Narrow-10 (210KHz)	Narrow-11 (210KHz)	
0	550284	541136	9148
500	503295	479261	24034
1000	443749	427613	16136
1500	383181	376136	7045
2000	324715	327954	-3239
2500	298011	305284	-7273
3000	275397	307784	-32387
3500	299318	305625	-6307
4000	305795	300738	5057
4500	300000	295000	5000
5000	282159	279261	2898
5500	273295	263920	9375
6000	274432	252670	21762
6500	263238	246079	17159
7000	255738	240682	15056
7500	246932	258352	-11420
8000	243863	250000	-6137
8500	254772	232897	21875
9000	255000	235170	19830
9500	257500	236818	20682
10000	288068	281761	6307
10500	287329	291875	-4546
11000	236988	262954	-25966
11500	292443	296079	-3636
12000	316477	312954	3523
12500	460795	451931	8864
13000	593465	588693	4772
13500	602954	604772	-1818
14000			
TOTAL	9369195	9253400	115795

Table 5.2.4-1(6) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-11 (210KHz)	Narrow-12 (210KHz)	
0	541136	557500	-16364
500	479261	498693	-19432
1000	427613	442215	-14602
1500	376136	387443	-11307
2000	327954	336477	-8523
2500	305284	314772	-9488
3000	307784	303125	4659
3500	305625	310738	-5113
4000	300738	304034	-3296
4500	295000	293750	1250
5000	279261	276477	2784
5500	263920	264488	-568
6000	252670	272557	-19887
6500	246079	269318	-23239
7000	240682	259716	-19034
7500	258352	254261	4091
8000	250000	263352	-13352
8500	232897	251534	-18637
9000	235170	253693	-18523
9500	236818	257216	-20398
10000	281761	297159	-15398
10500	291875	289034	2841
11000	262954	257102	5852
11500	296079	295284	795
12000	312954	320511	-7557
12500	451931	447670	4261
13000	588693	585681	3012
13500	604772	603749	1023
14000			
TOTAL	9253400	9467547	-214147

Table 5.2.4-1(7) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-5 (210KHz)	Narrow-6 (33KHz)	
0	565227	556874	8353
500	539090	522102	16988
1000	492556	506420	-13864
1500	422386	441363	-18977
2000	382045	384545	-2500
2500	355852	340113	15739
3000	349886	326875	23011
3500	353466	359375	-5909
4000	351591	392897	-41306
4500	341761	384545	-42784
5000	325113	342727	-17614
5500	330909	344886	-13977
6000	338750	336591	2159
6500	328863	329602	-739
7000	350966	309091	41875
7500	351647	307216	44431
8000	310738	313295	-2557
8500	309886	306477	3409
9000	305227	344602	-39375
9500	329091	346250	-17159
10000	352273	365625	-13352
10500	346119	394716	-48597
11000	320079	342670	-22591
11500	385341	353352	31989
12000	393181	382500	10681
12500	470454	481534	-11080
13000	552045	583977	-31932
13500	555227	586704	-31477
14000			
TOTAL	10809768	10986922	-177154

Distance	Water Volume		Increase Decrease
	Narrow-5 (210KHz)	Narrow-6 (210KHz)	
0	565227	556874	8353
500	539090	522102	16988
1000	492556	491988	568
1500	422386	425227	-2841
2000	382045	362613	19432
2500	355852	326818	29034
3000	349886	324716	25170
3500	353466	359375	-5909
4000	351591	379034	-27443
4500	341761	367613	-25852
5000	325113	340795	-15682
5500	330909	344772	-13863
6000	338750	320341	18409
6500	328863	322670	6193
7000	350966	309091	41875
7500	351647	307216	44431
8000	310738	274204	36534
8500	309886	242500	67386
9000	305227	284147	21080
9500	329091	336136	-7045
10000	352273	365625	-13352
10500	346119	381761	-35642
11000	320079	286306	33773
11500	385341	289716	95625
12000	393181	366022	27159
12500	470454	481534	-11080
13000	552045	583977	-31932
13500	555227	586704	-31477
14000			
TOTAL	10809768	10539876	269892

Table 5.2.4-1(8) Comparison of Water Volume Between Two Stages

Distance	Water Volume		Increase Decrease
	Narrow-6 (210KHz)	Narrow-7 (210KHz)	
0	556874	548920	7954
500	522102	495738	26364
1000	491988	433579	58409
1500	425227	367386	57841
2000	362613	316022	46591
2500	326818	278693	48125
3000	324716	272954	51762
3500	359375	299034	60341
4000	379034	296307	82727
4500	367613	282102	85511
5000	340795	261761	79034
5500	344772	259318	85454
6000	320341	248920	71421
6500	322670	235966	86704
7000	309091	213068	96023
7500	307216	214716	92500
8000	274204	217386	56818
8500	242500	210852	31648
9000	284147	216363	67784
9500	336136	233522	102614
10000	365625	254772	110853
10500	381761	236477	145284
11000	286306	206307	79999
11500	289716	281761	7955
12000	366022	329488	36534
12500	481534	451250	30284
13000	583977	570681	13296
13500	586704	585113	1591
14000			
TOTAL	10539876	8818457	1721419

Distance	Water Volume		Increase Decrease
	Narrow-5 (210KHz)	Narrow-7 (210KHz)	
0	565227	548920	16307
500	539090	495738	43352
1000	492556	433579	58977
1500	422386	367386	55000
2000	382045	316022	66023
2500	355852	278693	77159
3000	349886	272954	76932
3500	353466	299034	54432
4000	351591	296307	55284
4500	341761	282102	59659
5000	325113	261761	63352
5500	330909	259318	71591
6000	338750	248920	89830
6500	328863	235966	92897
7000	350966	213068	137898
7500	351647	214716	136931
8000	310738	217386	93352
8500	309886	210852	99034
9000	305227	216363	88864
9500	329091	233522	95569
10000	352273	254772	97501
10500	346119	236477	109642
11000	320079	206307	113772
11500	385341	281761	103580
12000	393181	329488	63693
12500	470454	451250	19204
13000	552045	570681	-18636
13500	555227	585113	-29886
14000			
TOTAL	10809768	8818457	1991311

5.3 General Survey

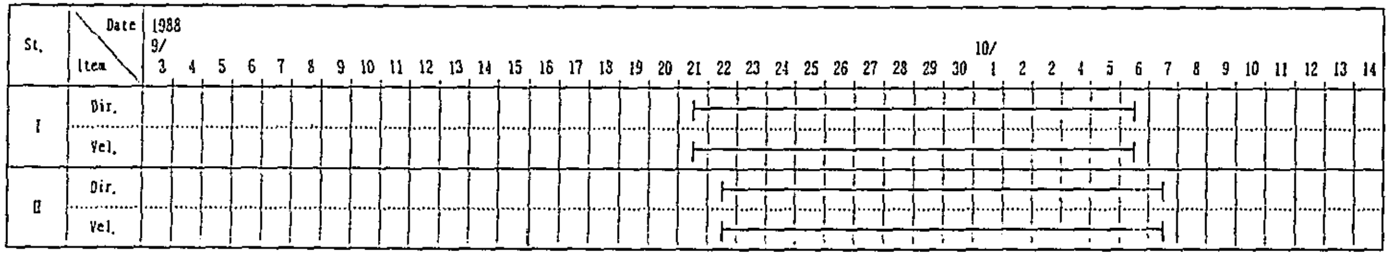
5.3.1 Tidal Currents

Tidal Currents Survey by continuous current observation were conducted for each 15 days every stage of General Surveys, such as dry season, rainy season and intermediate season from rainy to dry for the purpose of grasping the characteristics of current conditions in east and west side of shallow sea area extending in front of the mouth of Barito river.
Survey schedule was shown in Table 5.3.1-1 and survey durations were undermentioned.

- 1st Stage(Dry season) : 21st Sep. - 7th Oct. 1988
- 2nd Stage(Rainy season): 25th Jan. - 10th Feb. 1989
- 3rd Stage(Intermediate season between Rainy and Dry) : 14th Apr. - 30th Apr. 1989

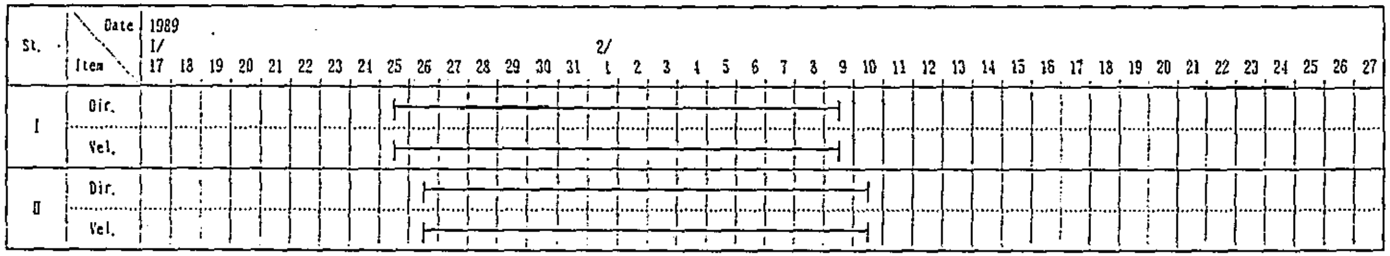
Table. 5.3.1 − 1 Achievement of Data Obtained (Tidal Currents)

(1st General Survey)



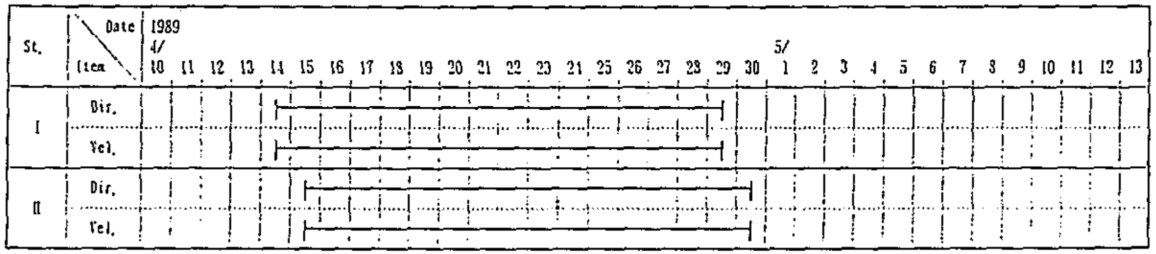
Note: —— shows Data obtained and ---- shows no Data.

(2nd General Survey)



Note: —— shows Data obtained and ---- shows no Data.

(3rd General Survey)



Note: —— shows Data obtained and ---- shows no Data.

1) Current Direction

Most appeared frequencies of direction at each station every stage are shown as under.

St.	I		II	
Stage	Direction	%	Direction	%
1st	NNW- N -NNE	25	N -NNE-N E	33
	ESE-S E-SSE	37	S E-SSE- S	29
2nd	WNW-N W-NNW	49	N -NNE-N E	29
	S E-SSE- S	24	SSE- S -SSW	24
3rd	WNW-N W-NNW	42	N -NNE-N E	28
	S E-SSE- S	25	SSE- S -SSW	31

According to above table, most appeared frequencies of current directions at St.I and II were divided into two directions, such as northward and southward in every stage.
However, examining the distributions of the frequencies, the appeared directions between St.I and II showed rather differ conditions with small deviation to E'ly or W'ly.
It is suggested that current directions in both most frequencies were flew along contour line of water depth adjacent to each station.

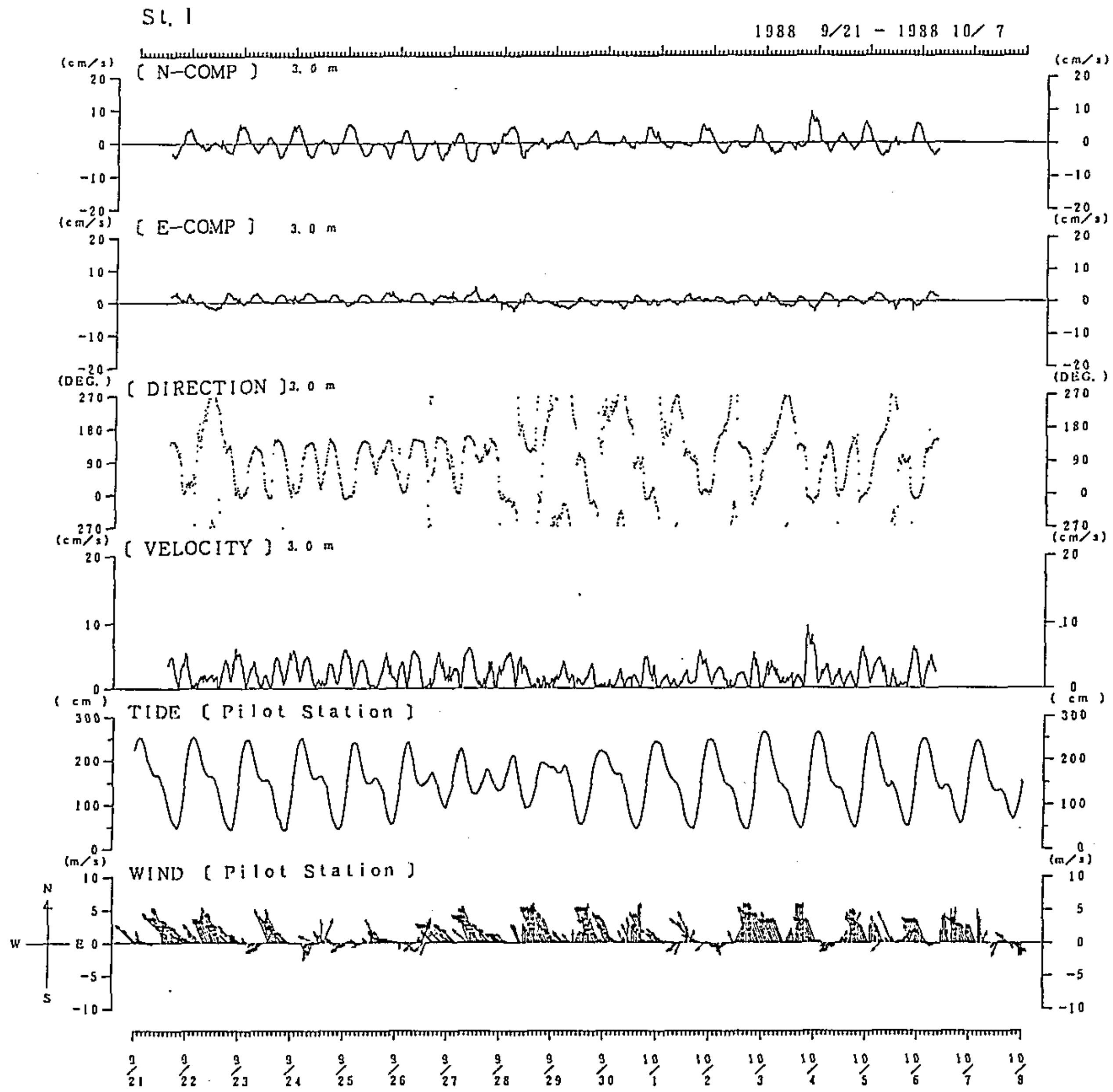


Fig. 5.3.1－1(1) Current Curve (Survey Item:Tidal Current, 1st Stage)

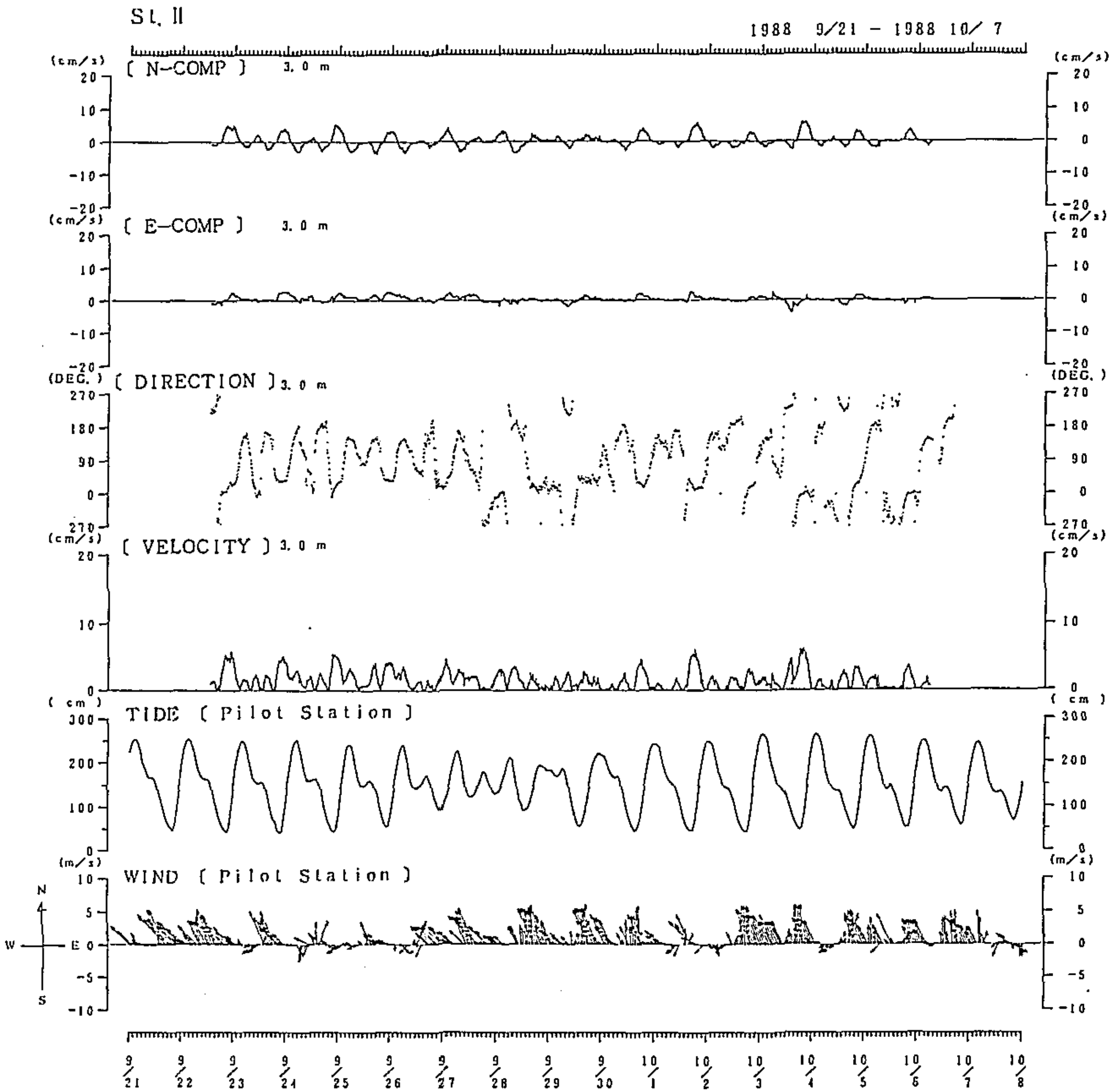


Fig. 5.3.1-1(2) Current Curve (Survey Item:Tidal Current, 1st Stage)

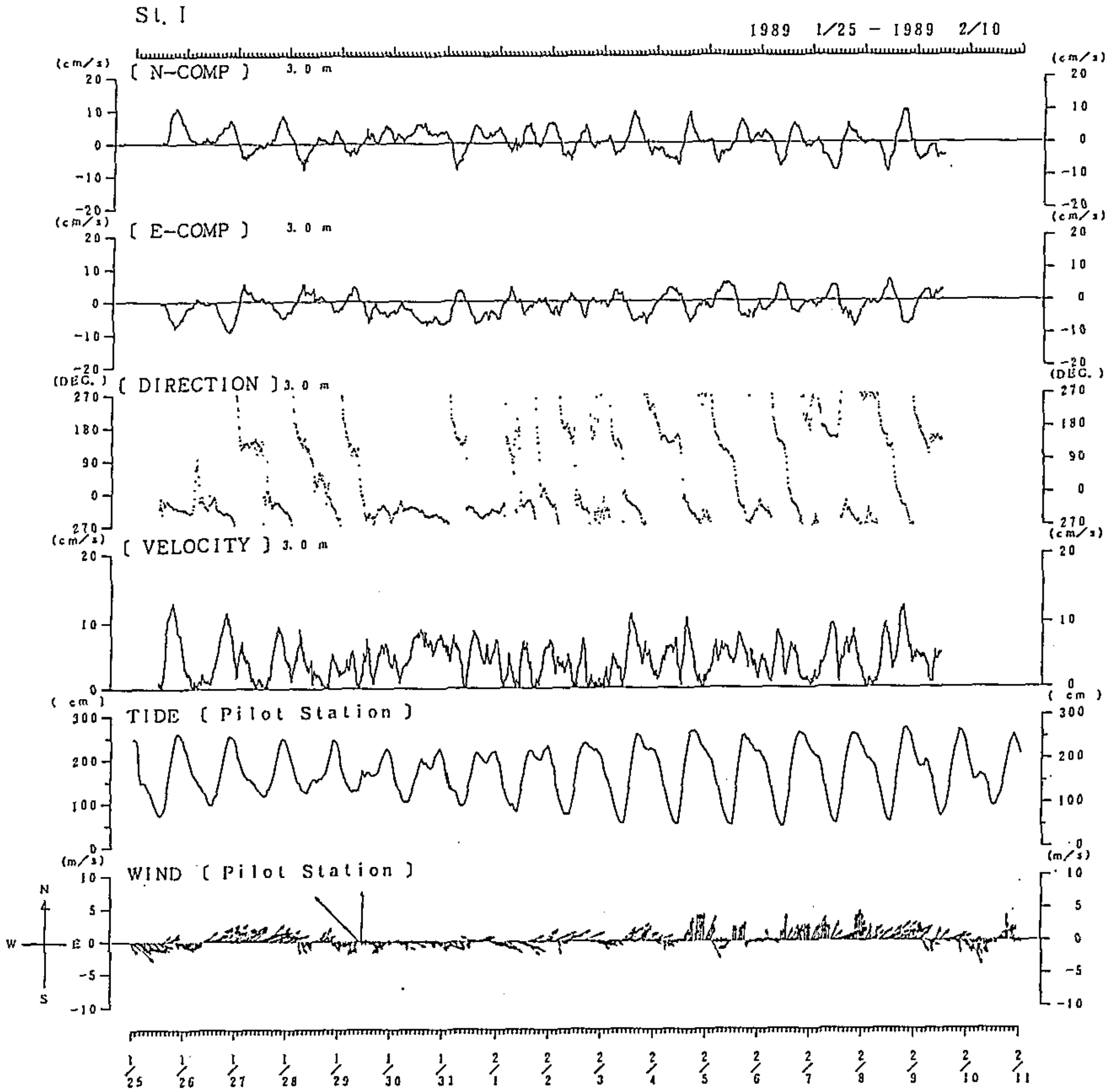


Fig. 5.3.1-1(3) Current Curve (Survey Item: Tidal Current, 2nd Stage)

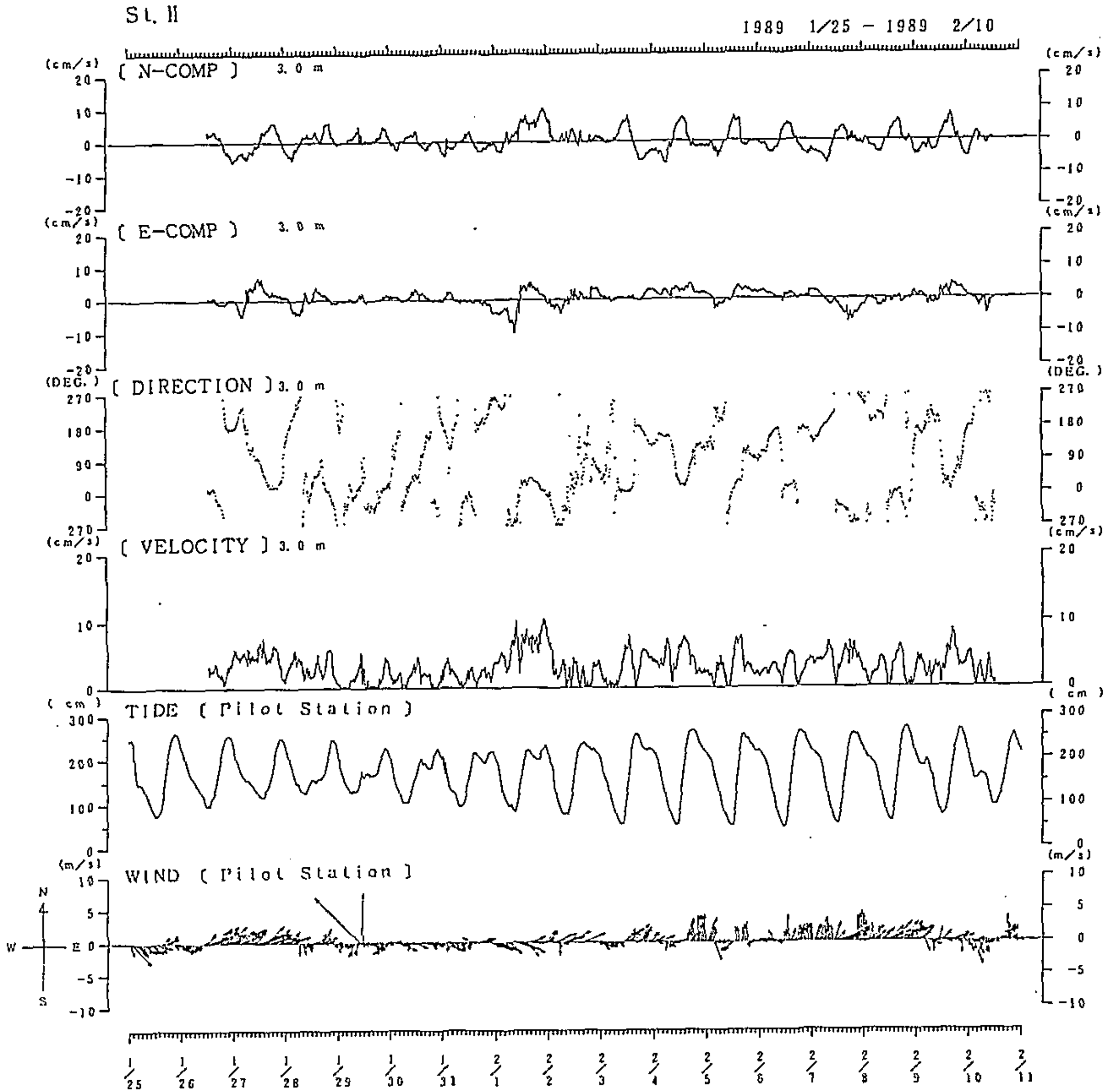


Fig. 5.3.1－1(4) Current Curve (Survey Item:Tidal Current, 2nd Stage)

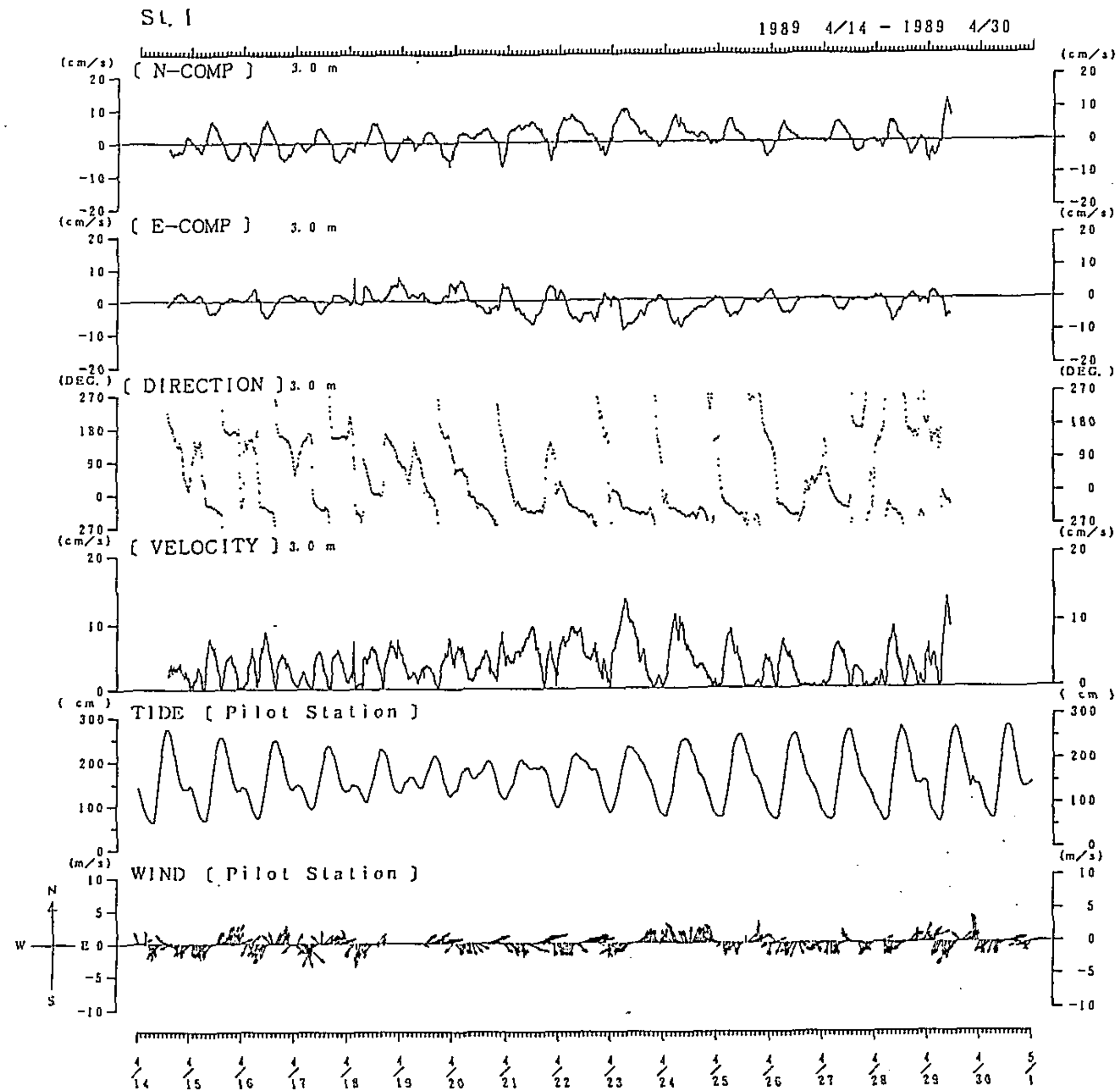


Fig. 5.3.1 − 1(5) Current Curve (Survey Item:Tidal Current, 3rd Stage)

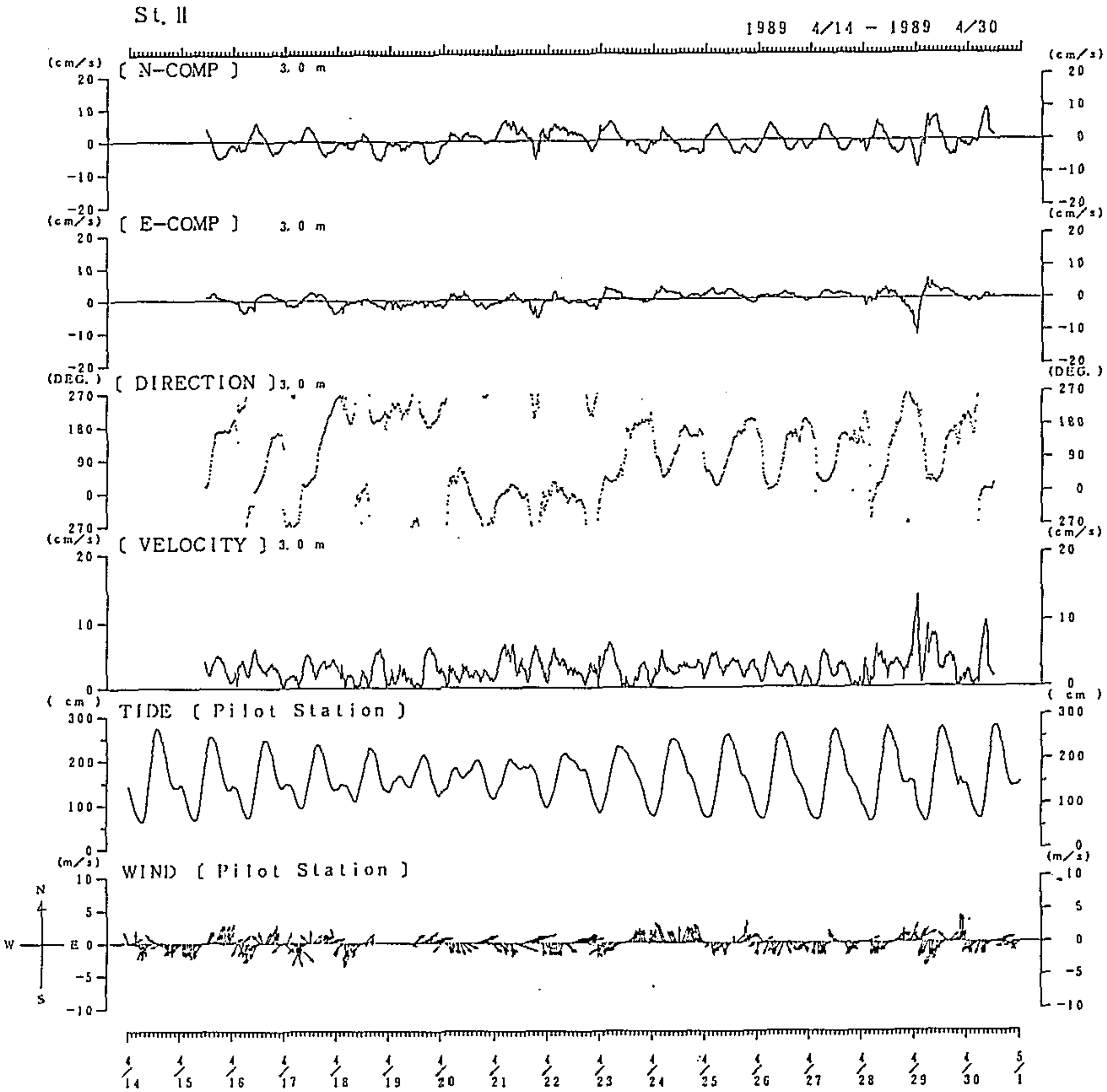


Fig. 5.3.1－1(6) Current Curve (Survey Item:Tidal Current, 3rd Stage)

2) Tidal current harmonic analysis

Tidal currents in the sea area are able to be classified as under by using results of tidal current harmonic analysis.

Semi-diurnal type : $\frac{K1 + O1}{M2 + S2} < 0.25$

Mixed type : $0.25 < \frac{K1 + O1}{M2 + S2} < 1.25$

Diurnal type : $1.25 < \frac{K1 + O1}{M2 + S2}$

Applying to each harmonic constants at St.I and St.II, following results were obtained.

(1st)

St. I : $\frac{K1 + O1}{M2 + S2} = \frac{1.9 + 0.6}{2.0 + 0.7} = 0.93$

St.II : $\frac{K1 + O1}{M2 + S2} = \frac{1.7 + 0.2}{1.5 + 0.4} = 1.0$

(2nd)

St. I : $\frac{K1 + O1}{M2 + S2} = \frac{3.6 + 0.9}{3.4 + 0.6} = 1.125$

St.II : $\frac{K1 + O1}{M2 + S2} = \frac{2.1 + 0.7}{2.0 + 0.6} = 1.08$

(3rd)

St. I : $\frac{K1 + O1}{M2 + S2} = \frac{3.9 + 0.3}{3.2 + 0.4} = 1.17$

St.II : $\frac{K1 + O1}{M2 + S2} = \frac{2.8 + 1.0}{2.3 + 0.3} = 1.45$

Judging from above results, tidal currents in the offing of shallow sea area in front of the Barito river belongs mixed type and show are near diurnal type.

Followings show the four principal tidal components extracted from results of tidal current harmonic analysis.

St.		I				II			
stage		K1	O1	M2	S2	K1	O1	M2	S2
1st	Amp. (cm)	1.9	0.6	2.0	0.7	1.7	0.2	1.5	0.4
	Phase(°)	246	154	41	319	240	101	332	241
2nd	Amp. (cm)	3.6	0.9	3.4	0.6	2.1	0.7	2.0	0.6
	Phase(°)	282	200	86	353	237	137	45	332
3rd	Amp. (cm)	3.9	0.3	3.2	0.4	2.8	1.0	2.3	0.3
	Phase(°)	270	146	81	305	247	187	59	302

K1 and M2 tidal component are rather large among four principal components but velocities are less than 4 cm/s and tidal currents are generally weak.

Examinig characteristics of period in the tidal current by using the power spectrum which calculated by B-T method as shown in Fig.5.3.1-3, significant two peaks existed at 12 hour and 25 hour. Existence of peaks were same as the abovementioned results.

Table. 5.3.1－2(1) Results of Harmonic Analysis
(Survey Item:Tidal Current, 1st General Survey)

St. I

114. 20.8 : E
-3. 35.6 : N

Layer : 3.0m
Period : 1988. 9. 21 15: 0 - 1988. 10. 6 15: 0
Azimuth : MAG. N.

Tidal	N - comp.		E - comp.		Elements of Ellipse				Principal Ax. 347.2	
comp.	Vel. M/S	Lag.	Vel. M/S	Lag.	Ax.	Dir.	Vel. M/S	Lag.	Vel. M/S	Lag.
K_1	0.019	244.1	0.003	125.7	L	355.6	0.019	244.7	0.019	245.9
					S	85.6	0.003	154.7		
O_1	0.007	155.5	0.001	235.3	L	1.2	0.007	155.6	0.006	154.0
					S	91.2	0.001	245.6		
P_1	0.006	244.1	0.001	125.7	L	355.6	0.006	244.7	0.006	245.9
					S	85.6	0.001	154.7		
Q_1	0.002	15.1	0.004	153.1	L	295.2	0.004	341.4	0.003	3.3
					S	25.2	0.001	71.4		
M_2	0.018	39.6	0.009	228.1	L	333.1	0.020	41.4	0.020	40.5
					S	63.1	0.001	311.4		
S_2	0.007	319.8	0.002	117.5	L	345.5	0.007	318.4	0.007	318.5
					S	75.5	0.001	48.4		
K_2	0.002	319.8	0.001	117.5	L	345.5	0.002	318.4	0.002	318.5
					S	75.5	0.000	48.4		
N_2	0.007	355.0	0.002	181.5	L	343.7	0.007	355.5	0.007	355.4
					S	73.7	0.000	265.5		
M_4	0.004	115.9	0.001	104.8	L	9.6	0.004	115.5	0.004	116.3
					S	99.6	0.000	25.5		
MS_4	0.003	224.4	0.002	329.2	L	343.8	0.003	214.2	0.003	216.3
					S	73.8	0.002	304.2		
Mean Cur.	m/sec 0.001		m/sec 0.006		81.1° 0.006 m/sec				m/sec 0.000	

St. II

114. 32.2 : E
-3. 42.4 : N

Layer : 3.0m
Period : 1988. 9. 22 13: 0 - 1988. 10. 7 13: 0
Azimuth : MAG. N.

Tidal	N - comp.		E - comp.		Elements of Ellipse				Principal Ax. 11.0	
comp.	Vel. M/S	Lag.	Vel. M/S	Lag.	Ax.	Dir.	Vel. M/S	Lag.	Vel. M/S	Lag.
K_1	0.016	208.1	0.004	250.1	L	10.6	0.017	209.9	0.017	209.9
					S	100.6	0.003	299.9		
O_1	0.002	100.9	0.000	99.3	L	4.3	0.002	100.9	0.002	100.9
					S	94.3	0.000	10.9		
P_1	0.005	208.1	0.001	250.1	L	10.6	0.005	209.9	0.005	209.9
					S	100.6	0.001	299.9		
Q_1	0.002	120.2	0.004	148.3	L	61.8	0.005	141.8	0.003	127.2
					S	151.8	0.001	231.8		
M_2	0.014	330.9	0.004	356.2	L	14.0	0.015	332.5	0.015	332.2
					S	104.0	0.002	62.5		
S_2	0.004	239.6	0.001	290.7	L	6.9	0.004	240.6	0.004	241.2
					S	96.9	0.001	330.6		
K_2	0.001	239.6	0.000	290.7	L	6.9	0.001	240.6	0.001	241.2
					S	96.9	0.000	330.6		
N_2	0.006	328.8	0.001	311.4	L	9.4	0.006	328.3	0.006	328.2
					S	99.4	0.000	238.3		
M_4	0.002	1.1	0.001	331.0	L	22.0	0.002	356.6	0.002	358.8
					S	112.0	0.000	266.6		
MS_4	0.002	133.7	0.000	340.6	L	353.8	0.002	134.0	0.002	133.0
					S	83.8	0.000	44.0		
Mean Cur.	m/sec 0.003		m/sec 0.004		53.9° 0.005 m/sec				m/sec 0.004	

Table. 5.3.1－2(2)　Results of Harmonic Analysis
(Survey Item:Tidal Current, 2nd General Survey)

St. I

114. 20.8 : E
-3. 35.6 : N

Layer : 3.0m
Period : 1989. 1.25 12: 0 - 1988. 2. 9 12: 0
Azimuth : MAG. N.

Tidal	N - comp.		E - comp.		Elements of Ellipse				Principal Ax. 322.5	
comp.	Vel. M/S	Lag.	Vel. M/S	Lag.	Ax.	Dir.	Vel. M/S	Lag.	Vel. M/S	Lag.
K_1	0.027	271.6	0.025	115.6	L S	317.5 47.5	0.036 0.008	282.6 192.6	0.036	281.5
O_1	0.008	185.7	0.006	46.2	L S	325.6 55.6	0.009 0.003	199.2 109.2	0.009	200.3
P_1	0.009	271.6	0.008	115.6	L S	317.5 47.5	0.012 0.003	282.6 192.6	0.012	281.5
Q_1	0.001	239.4	0.004	86.3	L S	285.7 15.7	0.004 0.001	264.2 174.2	0.003	258.6
M_2	0.029	74.5	0.021	286.4	L S	326.4 56.4	0.034 0.009	84.5 354.5	0.034	85.6
S_2	0.005	357.2	0.003	163.4	L S	332.3 62.3	0.006 0.001	354.2 84.2	0.006	353.2
K_2	0.001	357.2	0.001	163.4	L S	332.3 62.3	0.002 0.000	354.2 84.2	0.002	353.2
N_2	0.009	19.8	0.005	224.8	L S	331.3 61.3	0.010 0.002	25.7 295.7	0.010	27.4
M_4	0.001	159.8	0.001	77.1	L S	63.3 153.3	0.001 0.001	100.3 10.3	0.001	202.9
MS_4	0.001	64.3	0.000	319.1	L S	353.2 83.2	0.001 0.000	66.9 336.9	0.001	79.3
Mean Cur.	m/sec 0.008		m/sec -0.013		m/sec 302.6 0.015				m/sec 0.014	

St. II

114. 32.2 : E
-3. 42.4 : N

Layer : 3.0m
Period : 1989. 1.26 12:40 - 1989. 2.10 12:40
Azimuth : MAG. N.

Tidal	N - comp.		E - comp.		Elements of Ellipse				Principal Ax. 8.5	
comp.	Vel. M/S	Lag.	Vel. M/S	Lag.	Ax.	Dir.	Vel. M/S	Lag.	Vel. M/S	Lag.
K_1	0.020	234.9	0.008	268.9	L S	18.3 108.3	0.021 0.004	238.6 328.6	0.021	236.6
O_1	0.008	137.9	0.006	327.3	L S	325.5 55.5	0.010 0.001	141.0 51.0	0.007	136.9
P_1	0.007	234.9	0.003	268.9	L S	18.3 108.3	0.007 0.001	238.6 328.6	0.007	236.6
Q_1	0.002	211.4	0.000	274.7	L S	1.2 91.2	0.002 0.000	211.5 301.5	0.002	211.8
M_2	0.020	43.6	0.004	111.5	L S	4.3 94.3	0.020 0.004	44.3 134.3	0.020	45.1
S_2	0.006	331.1	0.004	335.6	L S	36.2 126.2	0.007 0.000	332.7 62.7	0.006	331.6
K_2	0.002	331.1	0.001	335.6	L S	36.2 126.2	0.002 0.000	332.7 62.7	0.002	331.6
N_2	0.005	349.3	0.006	6.3	L S	52.5 142.5	0.008 0.001	360.0 90.0	0.006	352.0
M_4	0.002	123.4	0.002	132.6	L S	41.0 131.0	0.003 0.000	127.3 217.3	0.002	124.4
MS_4	0.001	91.2	0.001	280.8	L S	305.5 35.5	0.002 0.000	97.6 7.6	0.001	88.8
Mean Cur.	m/sec 0.003		m/sec 0.004		m/sec 48.5 0.005				m/sec 0.004	

Table. 5.3.1 − 2(3) Results of Harmonic Analysis
(Survey Item:Tidal Current, 3rd General Survey)

St. I

114. 20.8 : E
-3. 35.6 : N

Layer : 3.0m
Period : 1989. 4. 14 13:30 - 1989. 4. 29 13:30
Azimuth : MAG. N.

Tidal comp.	N - comp. Vel. M/S	N - comp. Lag.	E - comp. Vel. M/S	E - comp. Lag.	Elements of Ellipse Ax.	Dir.	Vel. M/S	Lag.	Principal Ax. 326.1 Vel. M/S	Lag.
K_1	0.032	259.6	0.025	111.2	L	322.9	0.039	271.3	0.039	270.4
					S	52.9	0.011	181.3		
O_1	0.003	152.6	0.001	303.2	L	339.1	0.003	148.7	0.003	146.3
					S	69.1	0.001	238.7		
P_1	0.011	259.6	0.008	111.2	L	322.9	0.013	271.3	0.013	270.4
					S	52.9	0.004	181.3		
Q_1	0.003	54.1	0.003	286.2	L	323.0	0.004	73.9	0.004	72.4
					S	53.0	0.002	343.9		
M_2	0.029	72.6	0.015	284.8	L	334.8	0.032	78.8	0.032	80.8
					S	64.8	0.007	348.8		
S_2	0.004	337.0	0.004	84.0	L	300.1	0.005	286.3	0.004	305.3
					S	30.1	0.003	16.3		
K_2	0.001	337.0	0.001	84.0	L	300.1	0.001	286.3	0.001	305.3
					S	30.1	0.001	16.3		
N_2	0.009	35.5	0.006	234.9	L	326.9	0.010	41.4	0.010	41.5
					S	56.9	0.002	311.4		
M_4	0.003	74.9	0.002	348.6	L	2.3	0.003	73.8	0.003	93.0
					S	92.3	0.002	343.8		
MS_4	0.002	284.9	0.000	117.6	L	346.9	0.002	285.6	0.002	286.6
					S	76.9	0.000	195.6		
Mean Cur.	m/sec 0.011		m/sec -0.007			326.9	0.014	m/sec	m/sec 0.014	

St. II

114. 32.2 : E
-3. 42.4 : N

Layer : 3.0m
Period : 1989. 4. 15 12: 0 - 1989. 4. 30 12: 0
Azimuth : MAG. N.

Tidal comp.	N - comp. Vel. M/S	N - comp. Lag.	E - comp. Vel. M/S	E - comp. Lag.	Elements of Ellipse Ax.	Dir.	Vel. M/S	Lag.	Principal Ax. 17.9 Vel. M/S	Lag.
K_1	0.027	242.2	0.011	287.1	L	18.1	0.028	247.3	0.028	247.2
					S	108.1	0.008	337.3		
O_1	0.009	172.0	0.010	231.5	L	53.6	0.012	209.1	0.010	187.2
					S	143.6	0.006	299.1		
P_1	0.009	242.2	0.004	287.1	L	18.1	0.009	247.3	0.009	247.2
					S	108.1	0.003	337.3		
Q_1	0.002	108.9	0.004	172.1	L	66.6	0.004	159.3	0.003	128.4
					S	156.6	0.002	249.3		
M_2	0.023	60.7	0.004	29.7	L	7.9	0.024	60.1	0.023	59.3
					S	97.9	0.002	330.1		
S_2	0.004	301.5	0.001	114.7	L	341.6	0.004	300.8	0.003	302.3
					S	71.6	0.000	30.8		
K_2	0.001	301.5	0.000	114.7	L	341.6	0.001	300.8	0.001	302.3
					S	71.6	0.000	30.8		
N_2	0.010	32.1	0.003	4.3	L	12.9	0.011	30.6	0.011	30.0
					S	102.9	0.001	300.6		
M_4	0.002	104.8	0.001	136.4	L	29.0	0.002	112.5	0.002	109.8
					S	119.0	0.001	202.5		
MS_4	0.003	213.5	0.000	298.9	L	0.2	0.003	213.5	0.003	214.5
					S	90.2	0.000	303.5		
Mean Cur.	m/sec 0.000		m/sec 0.002			79.1	0.002	m/sec	m/sec 0.001	

Table. 5.3.1－3 Diffusion Coefficients of Tidal Current

Unit: cm²/sec

Stage \ Item \ St.	I		II	
	N－comp	E－comp	N－comp	E－comp
1st General Survey	1989. 9/21 15ʰ 00ᵐ ～ 10/6 8ʰ 00ᵐ		1988. 9/22 13ʰ 00ᵐ ～ 10/7 10ʰ 00ᵐ	
	4.80×10^4	1.31×10^4	2.61×10^4	2.40×10^4
2nd General Survey	1989. 1/25 12ʰ 00ᵐ ～ 2/9 11ʰ 50ᵐ		1989. 1/26 12ʰ 40ᵐ ～ 2/10 12ʰ 30ᵐ	
	1.43×10^5	1.22×10^5	1.13×10^5	6.84×10^4
3rd General Survey	1989. 4/14 13ʰ 30ᵐ ～ 4/29 10ʰ 40ᵐ		1989. 4/15 12ʰ 00ᵐ ～ 4/30 11ʰ 50ᵐ	
	1.27×10^5	1.18×10^5	9.20×10^4	4.12×10^4

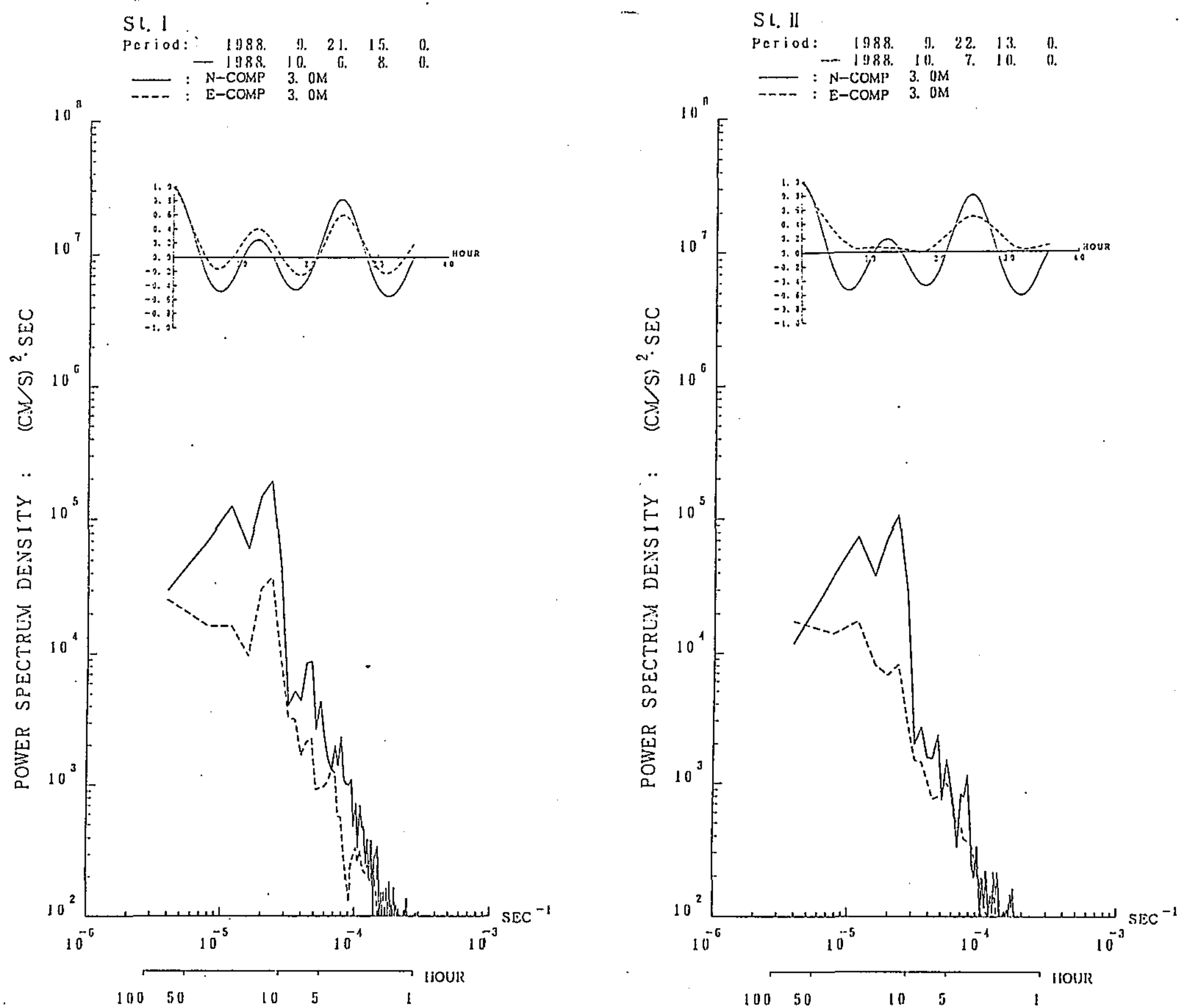


Fig. 5.3.1－2(1) Power Spectrum of Current (Survey Item: Tidal Current, 1st Stage)

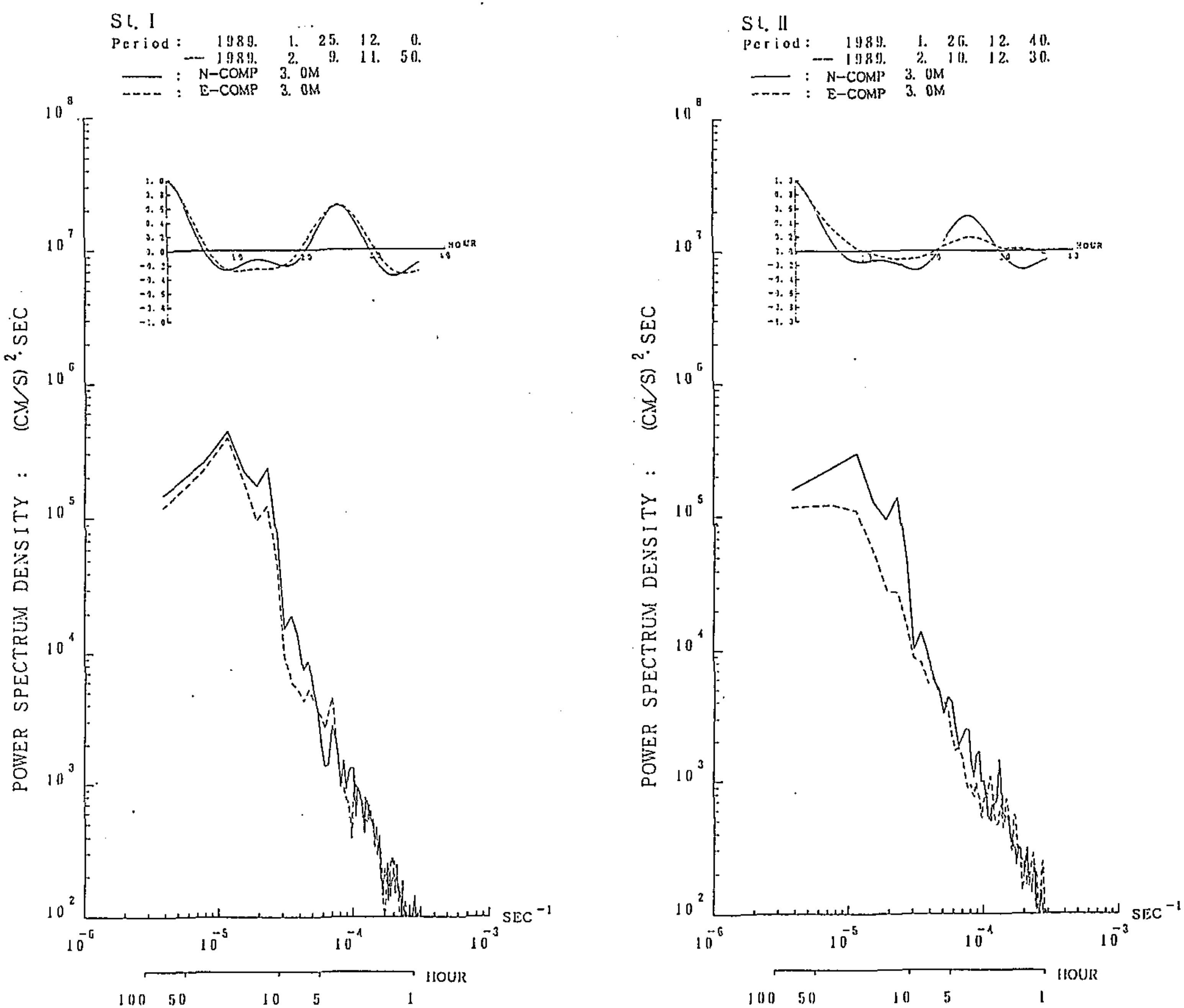
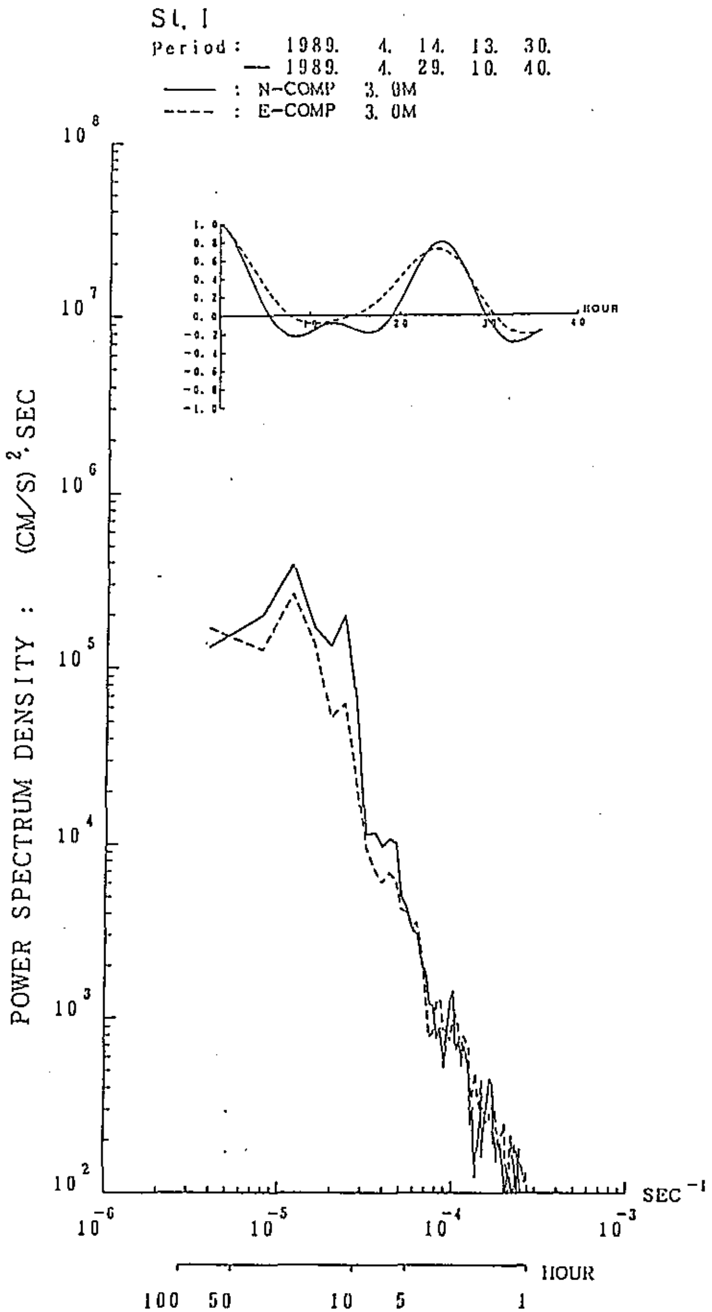


Fig. 5.3.1－2(2) Power Spectrum of Current (Survey Item: Tidal Current, 2nd Stage)



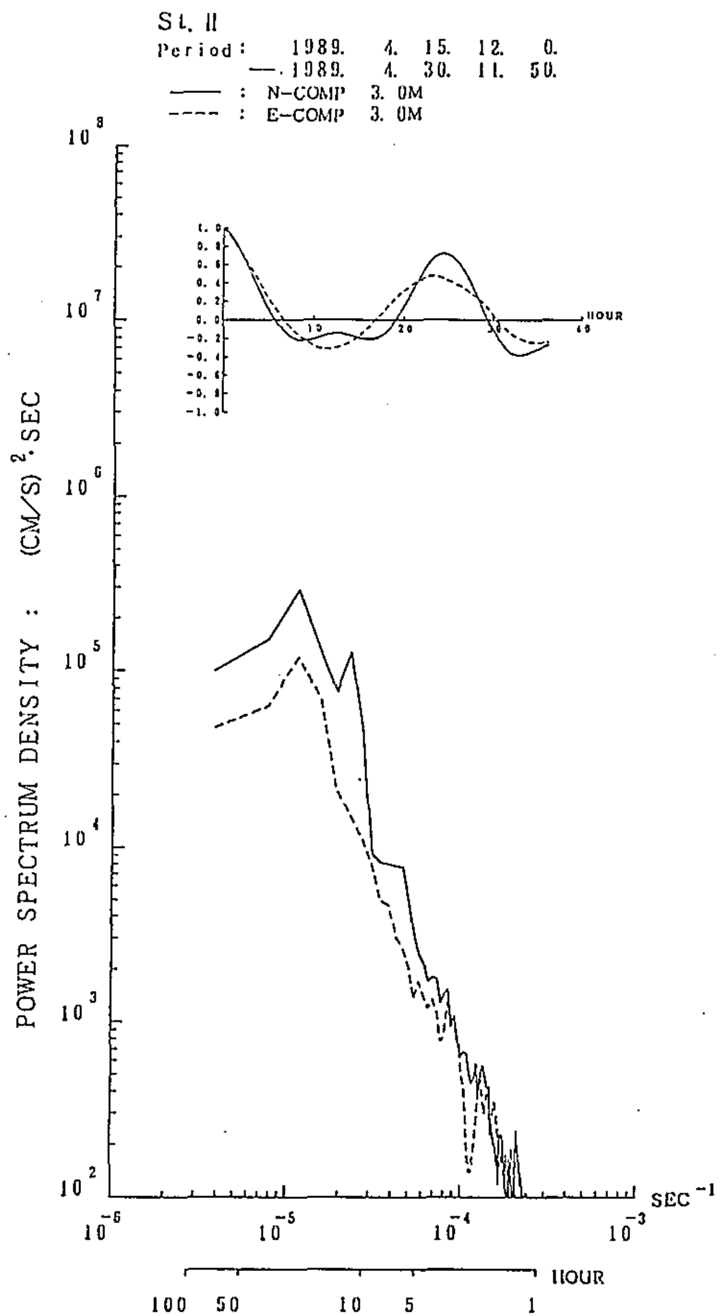


Fig. 5.3.1－2(3) Power Spectrum of Current (Survey Item: Tidal Current, 3rd Stage).

5.3.2 Current Distribution

Current distribution observation by each 30 days for continuous observation every stage of General Survey was conducted for the purpose of grasping the characteristics of current condition around the Access Channel in front of the Barito river. Type of season for General Survey were dry, rainy and intermediate season from rainy to dry season. Observational durations were basically established for 30 days about stations near the Access Channel and for 15 days about staions in both wing area, in the east and west side, of the Access Channel.
Survey schedule are shown in Table 5.3.2-1 and survey durations are as under.

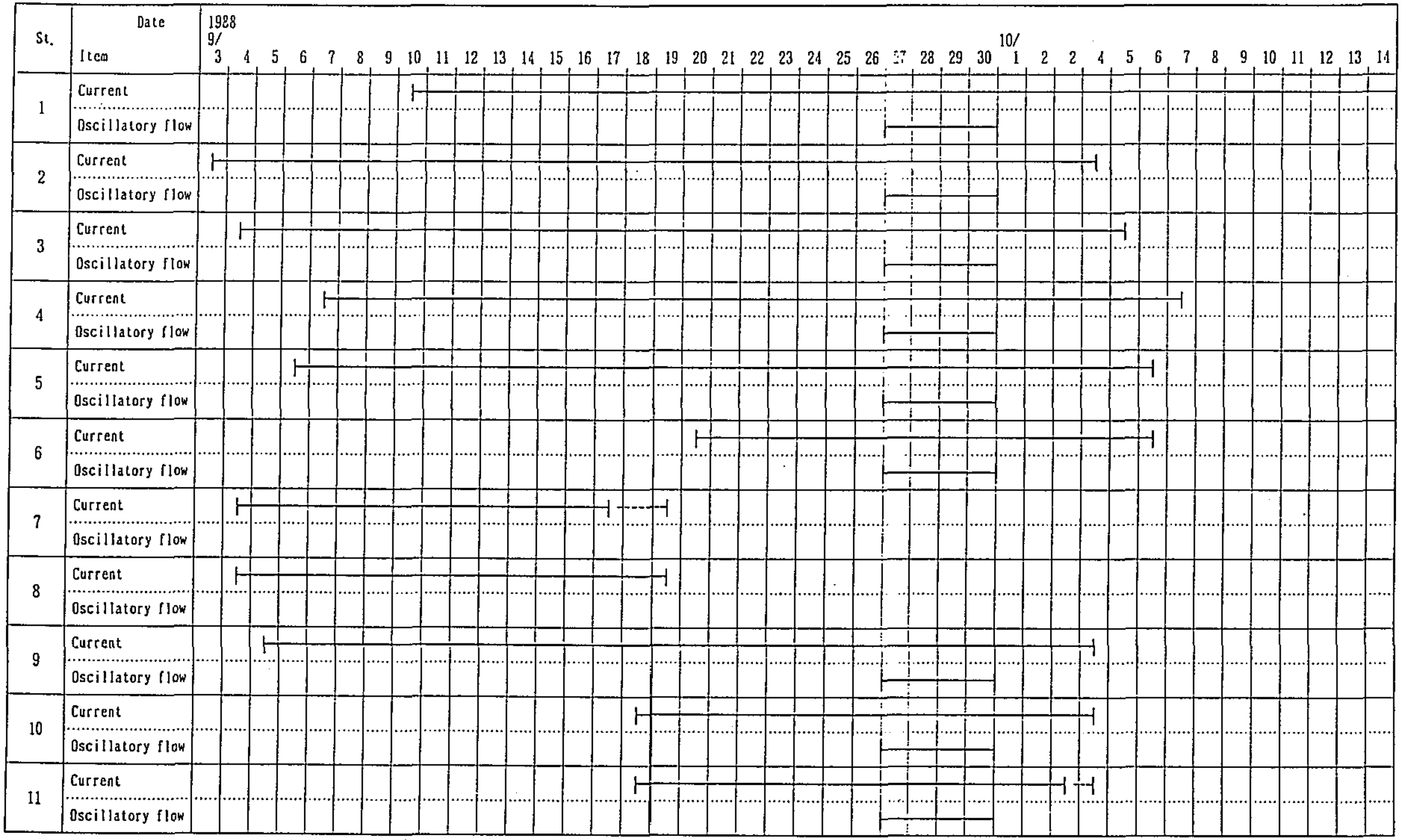
- 1st stage(Dry season) : 3rd Sep. - 7th Oct.1988

- 2nd stage(Rainy season) :17th Jan. -19th Feb.1989

- 3rd stage(Intermediate season between rainy and dry) :10th Apr. -13th May 1989

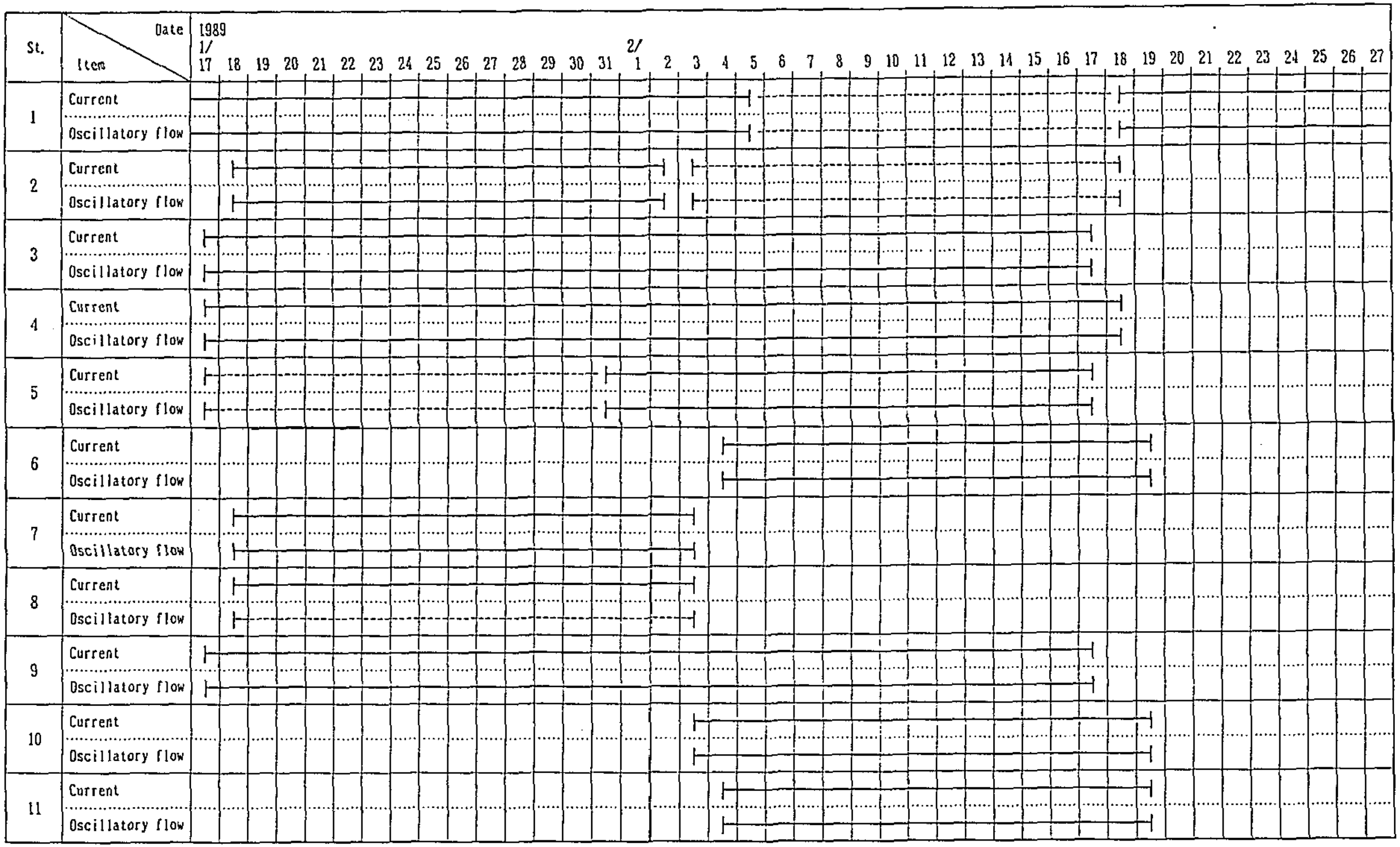
Original data for this analysis used mean value which had been measured by electromagnetic currentmeter with 0.5sec intervals data for burst duration in 2min. 8sec.

Table. 5.3.2 − 1(1) Achievement of Data Obtained (Current Distribution, 1st Stage)



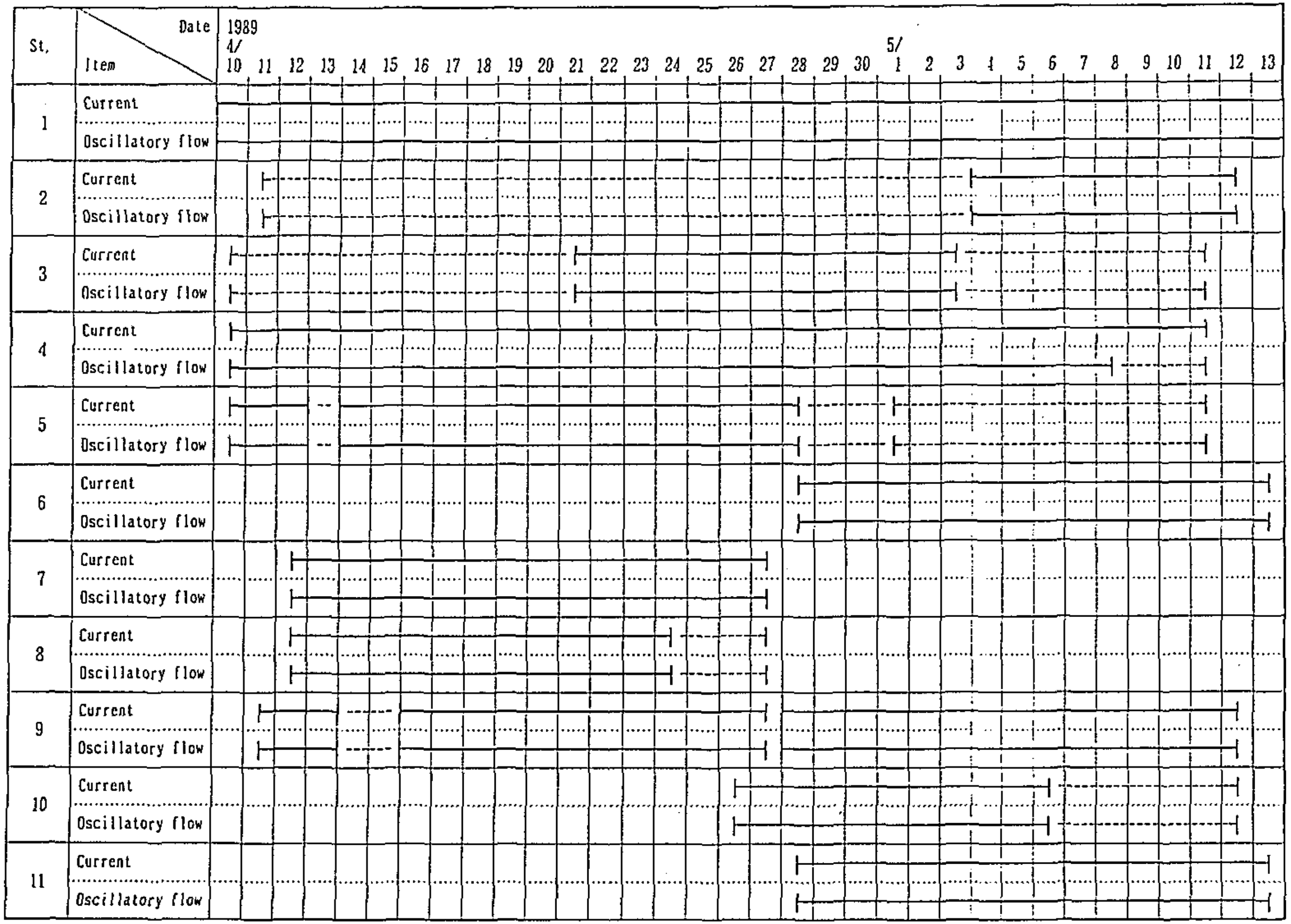
Note: —— shows Data obtained and ---- shows no Data.

Table. 5.3.2－1(2) Achievement of Data Obtained (Current Distribution, 2nd Stage)



Note: —— shows Data obtained and ---- shows no Data.

Table. 5.3.2 − 1(3) Achievement of Data Obtained (Current Distribution, 3rd Stage)



Note: —— shows Data obtained and ---- shows no Data.

1) Current Directions

Frequency distribution of current directions was shown in Fig. 5.3.2-1.
Examining the current in the survey sea area, a pattern of distribution for current directions in east side area where includes the mouth of Barito river and the Access Channel showed traces of stream with long and narrow from south to north direction with going and returning stream.
On the contrary, in the west side area, currents in N-NNE or S-SSW direction appeared mainly but frequencies of distribution of the directions showed rather random and main direction of current changed at times.

Pattern of current not showed simple condition as seen in east side area. Thus the pattern of current distribution showed rather differ between eastern area and western area as centering the Access Channel.

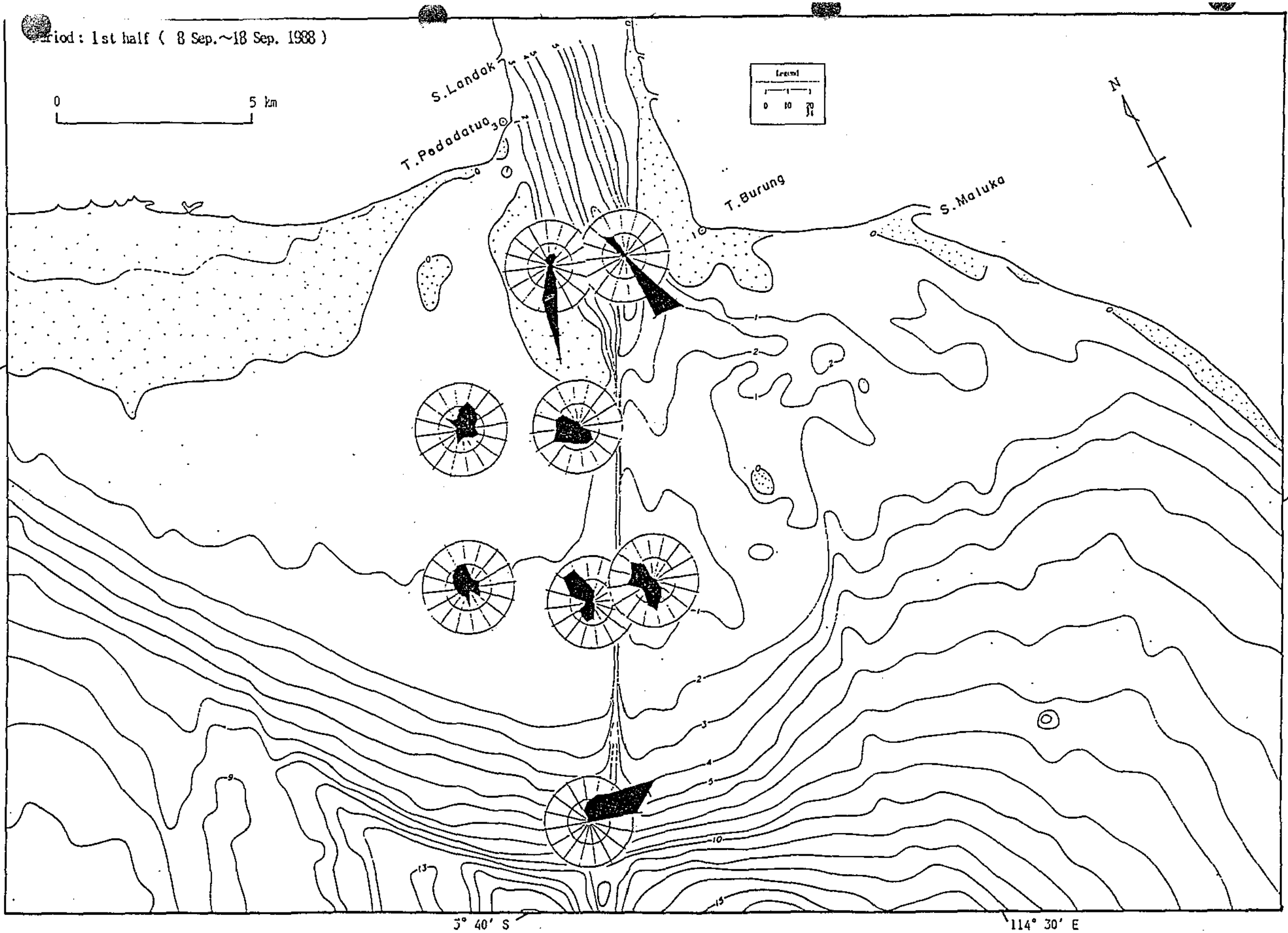


Fig. 5.3.2－1(1) Frequency Distribution of Current Direction (1st General Survey)

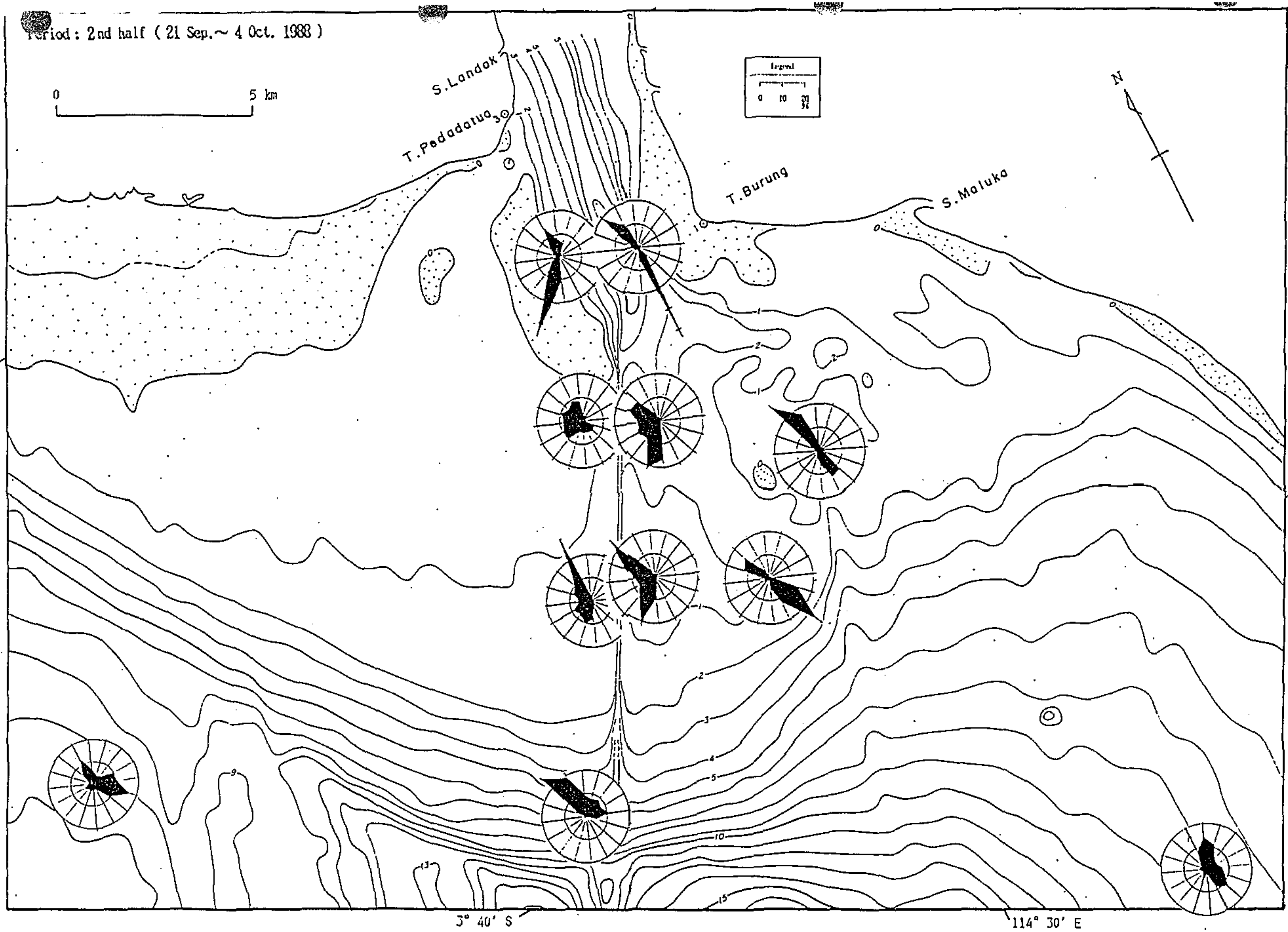


Fig. 5.3.2－1(2) Frequency Distribution of Current Direction (1st General Survey)

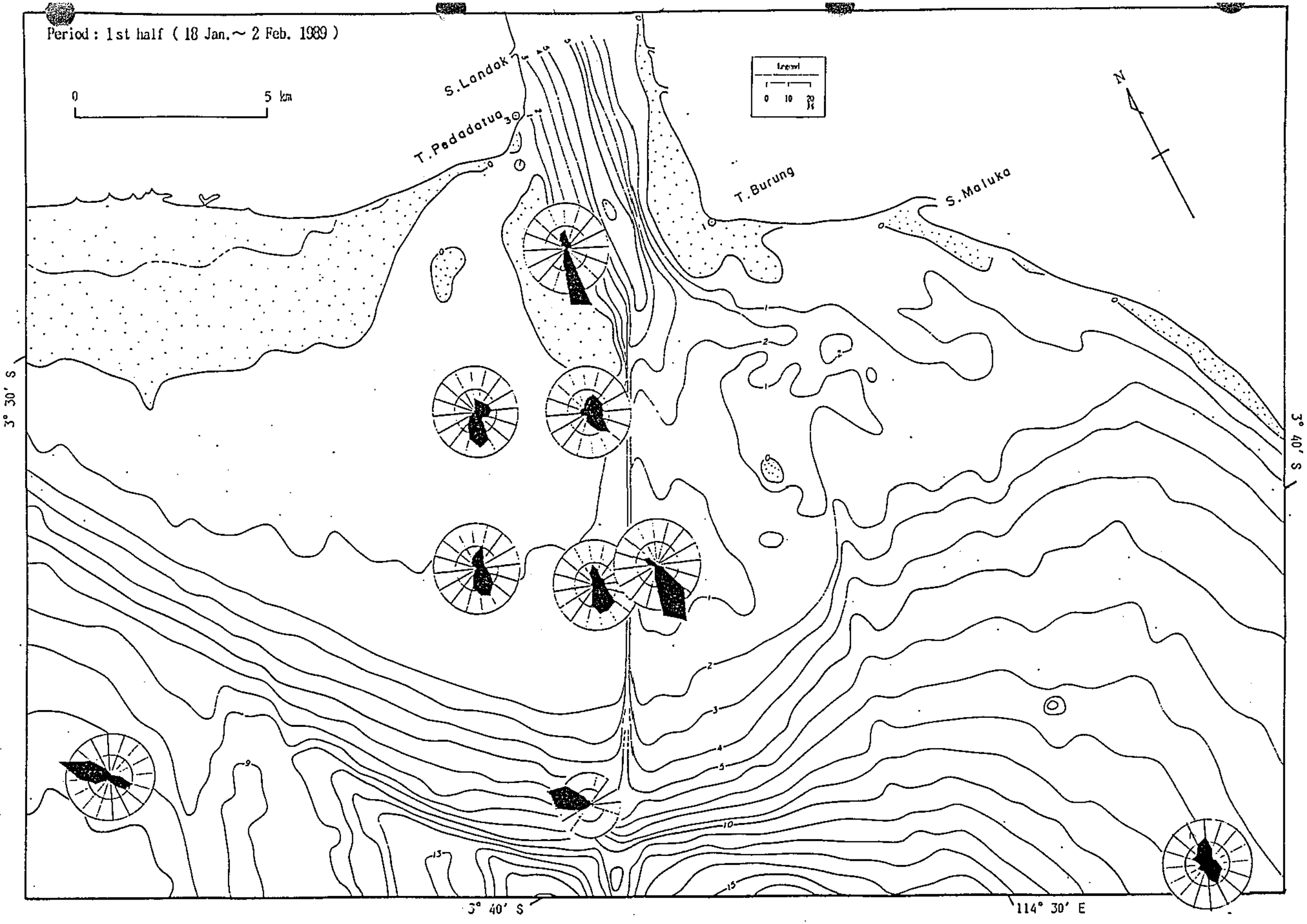


Fig. 5.3.2－1(3) Frequency Distribution of Current Direction (2nd General Survey)

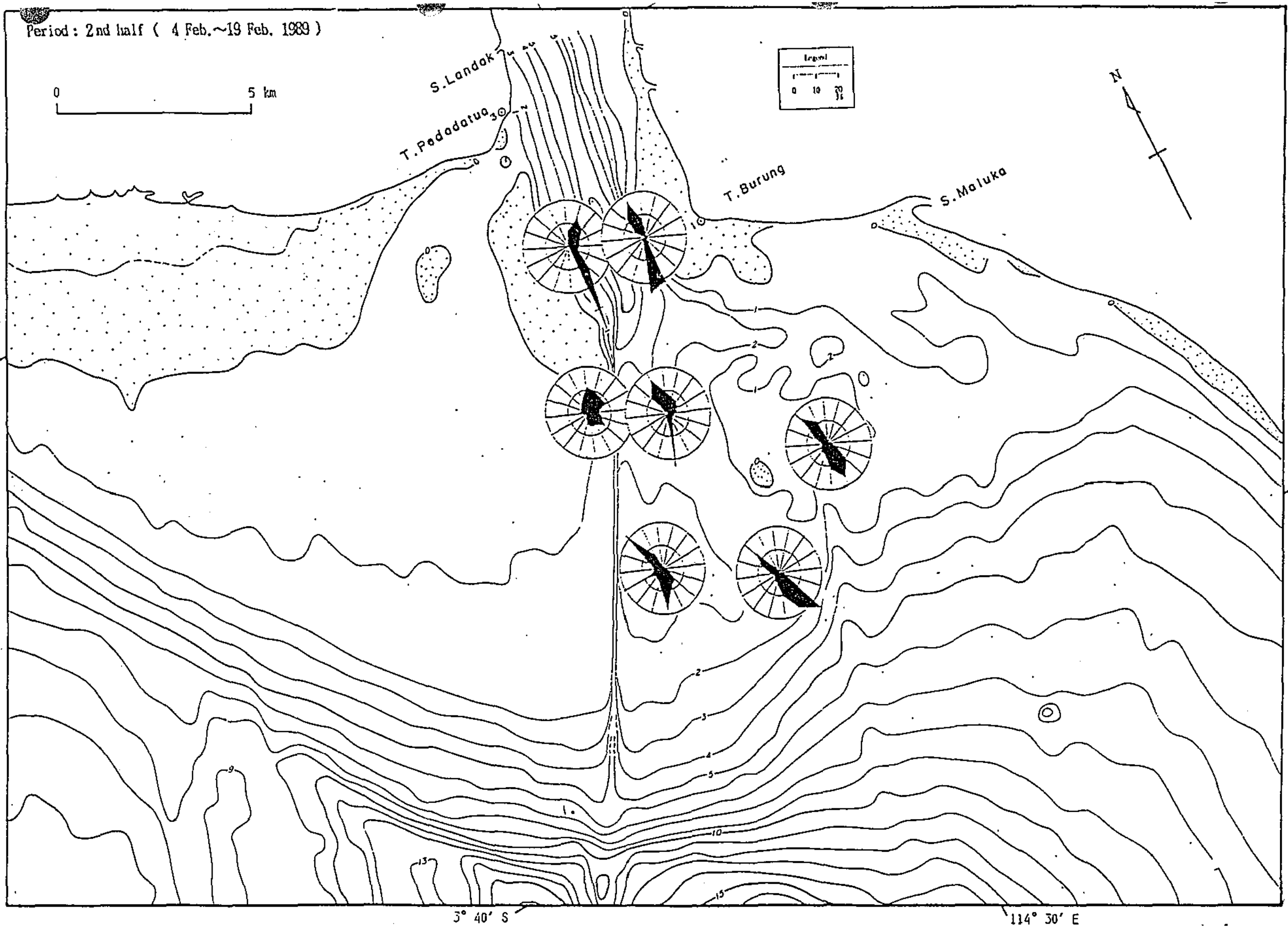


Fig. 5.3.2－1(4) Frequency Distribution of Current Direction (2nd General Survey)

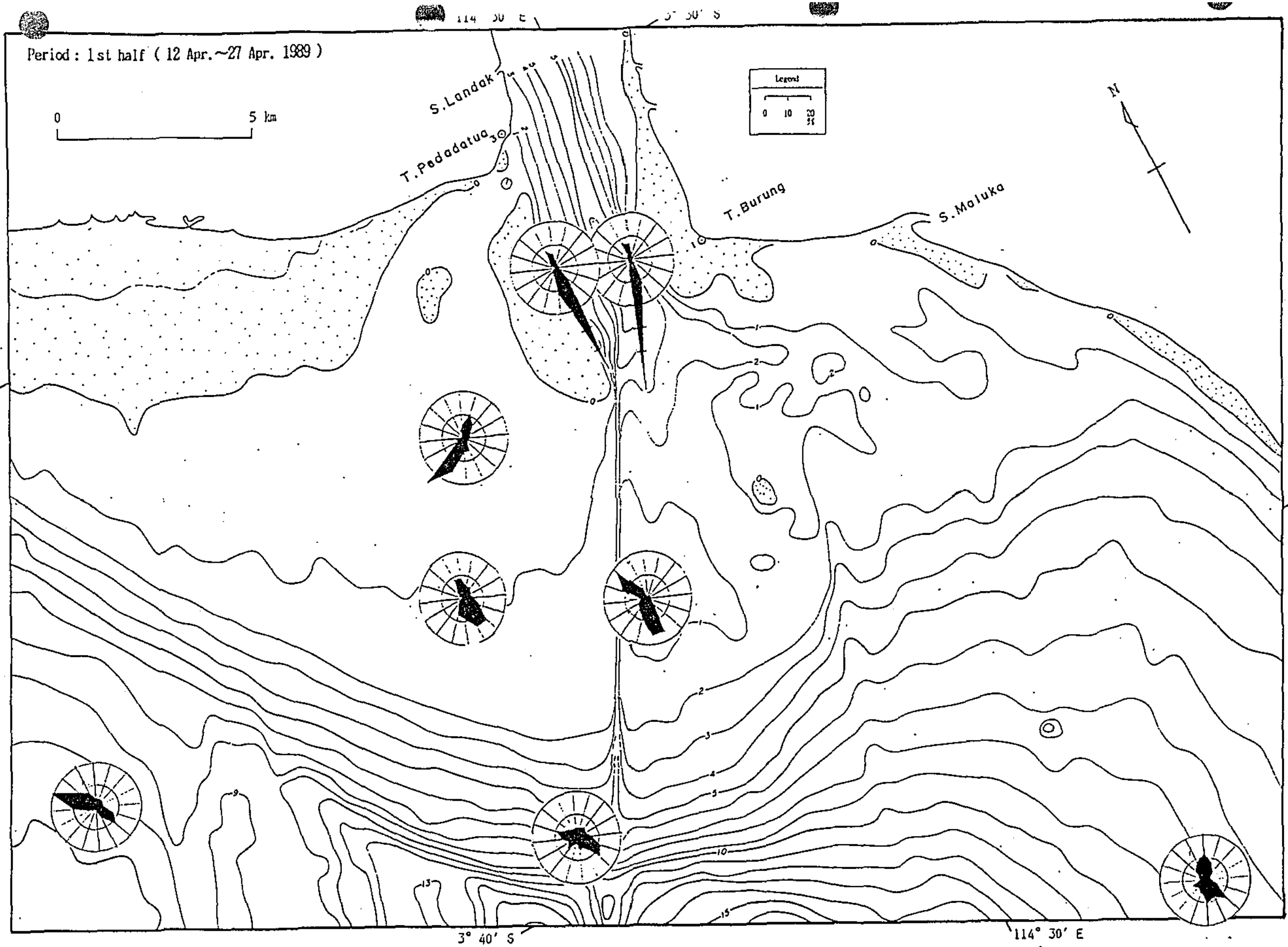


Fig. 5.3.2 − 1(5) Frequency Distribution of Current Direction (3rd General Survey)

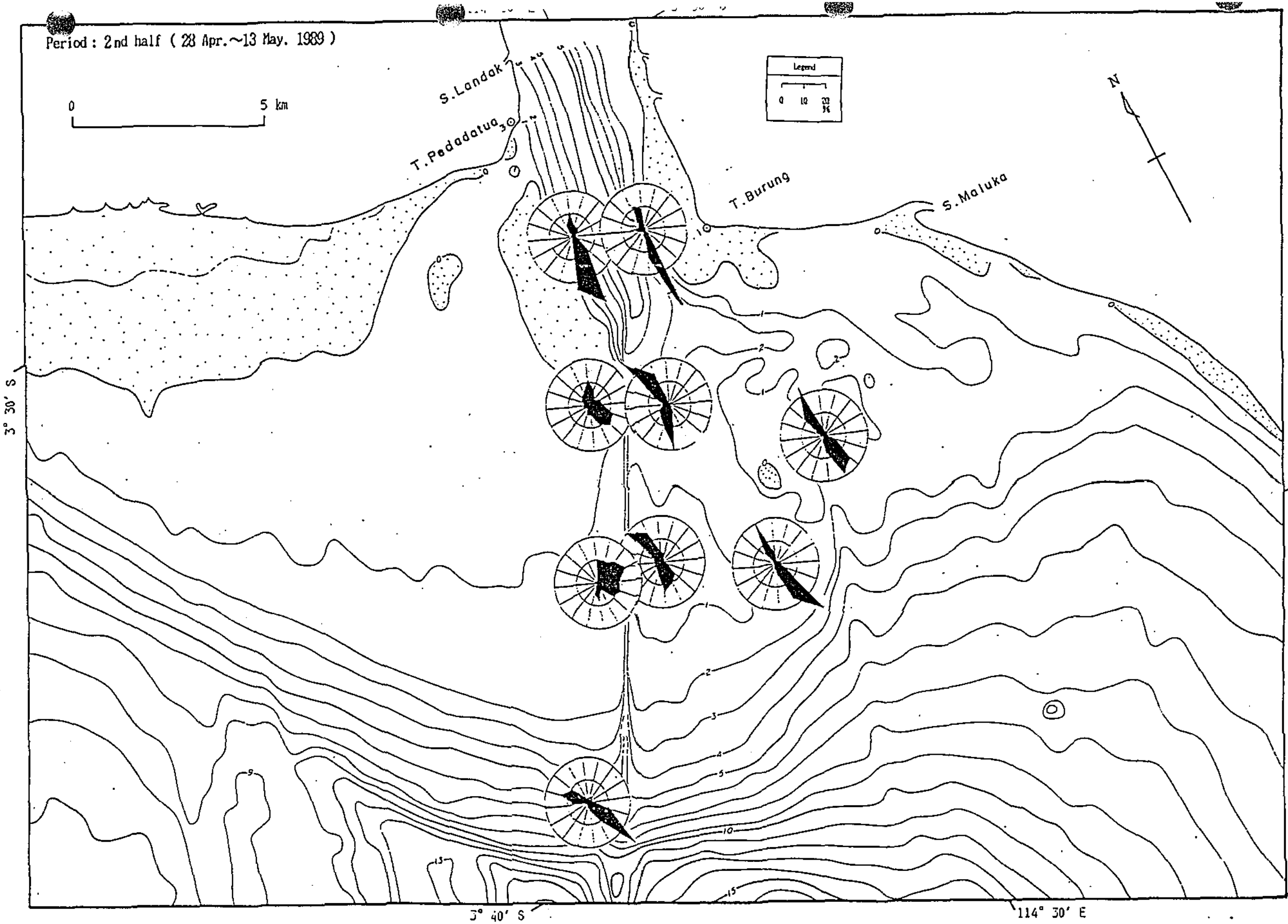


Fig. 5.3.2 − 1(6) Frequency Distribution of Current Direction (3rd General Survey)

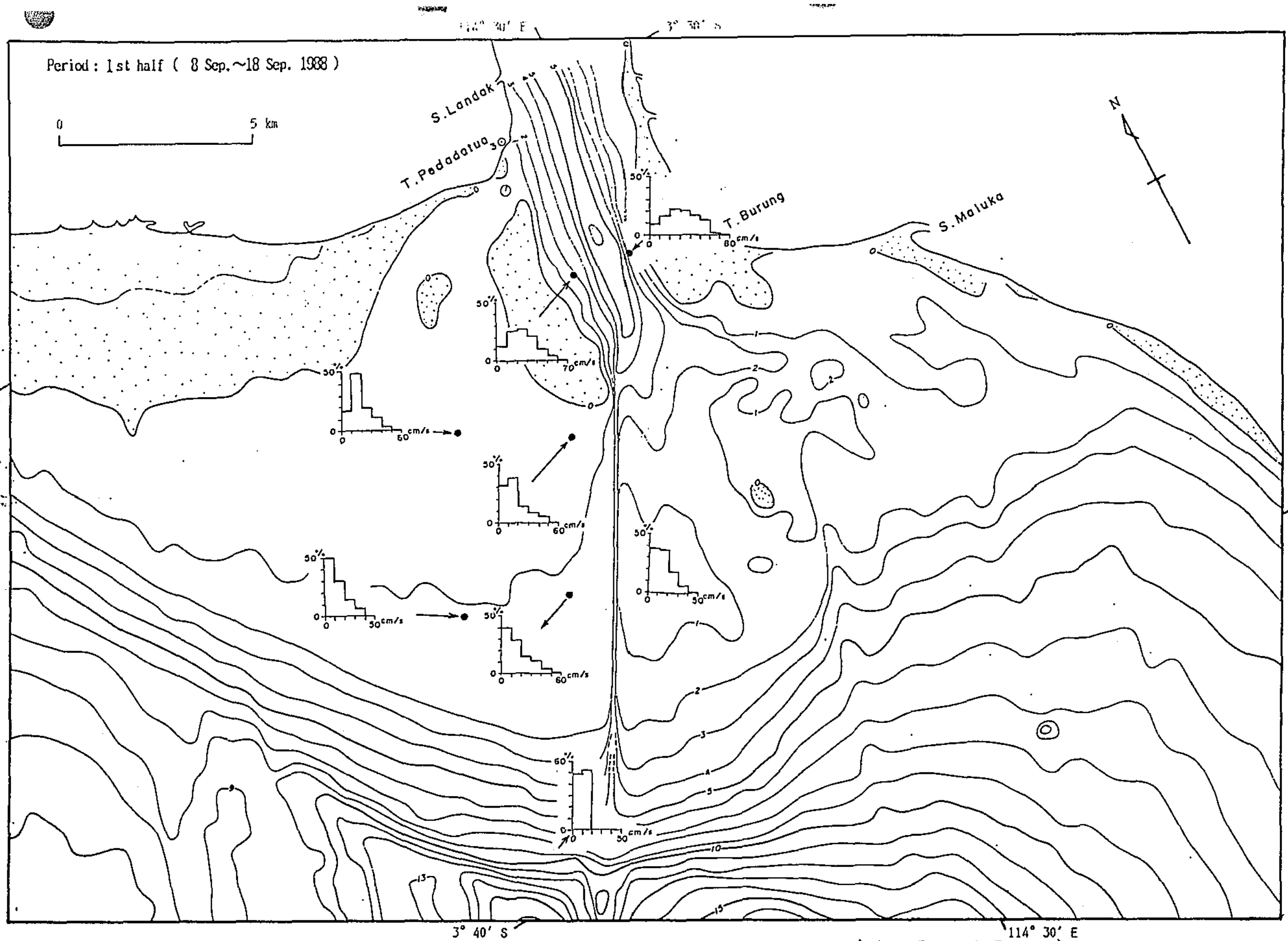


Fig. 5.3.2 − 2(1)   Frequency Distribution of Current Velocity (1st General Survey)

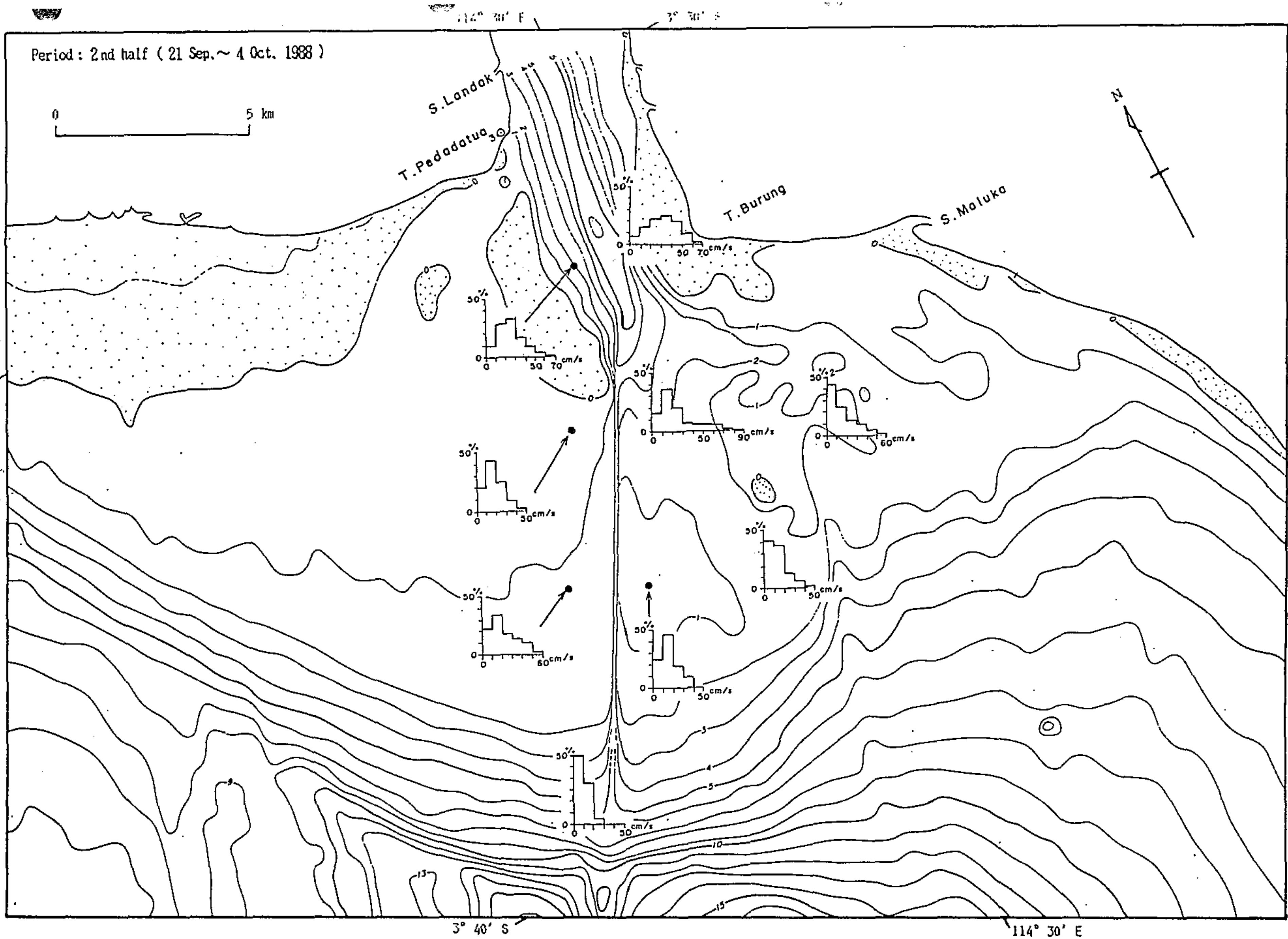


Fig. 5.3.2 − 2(2) Frequency Distribution of Current Velocity (1st General Survey)

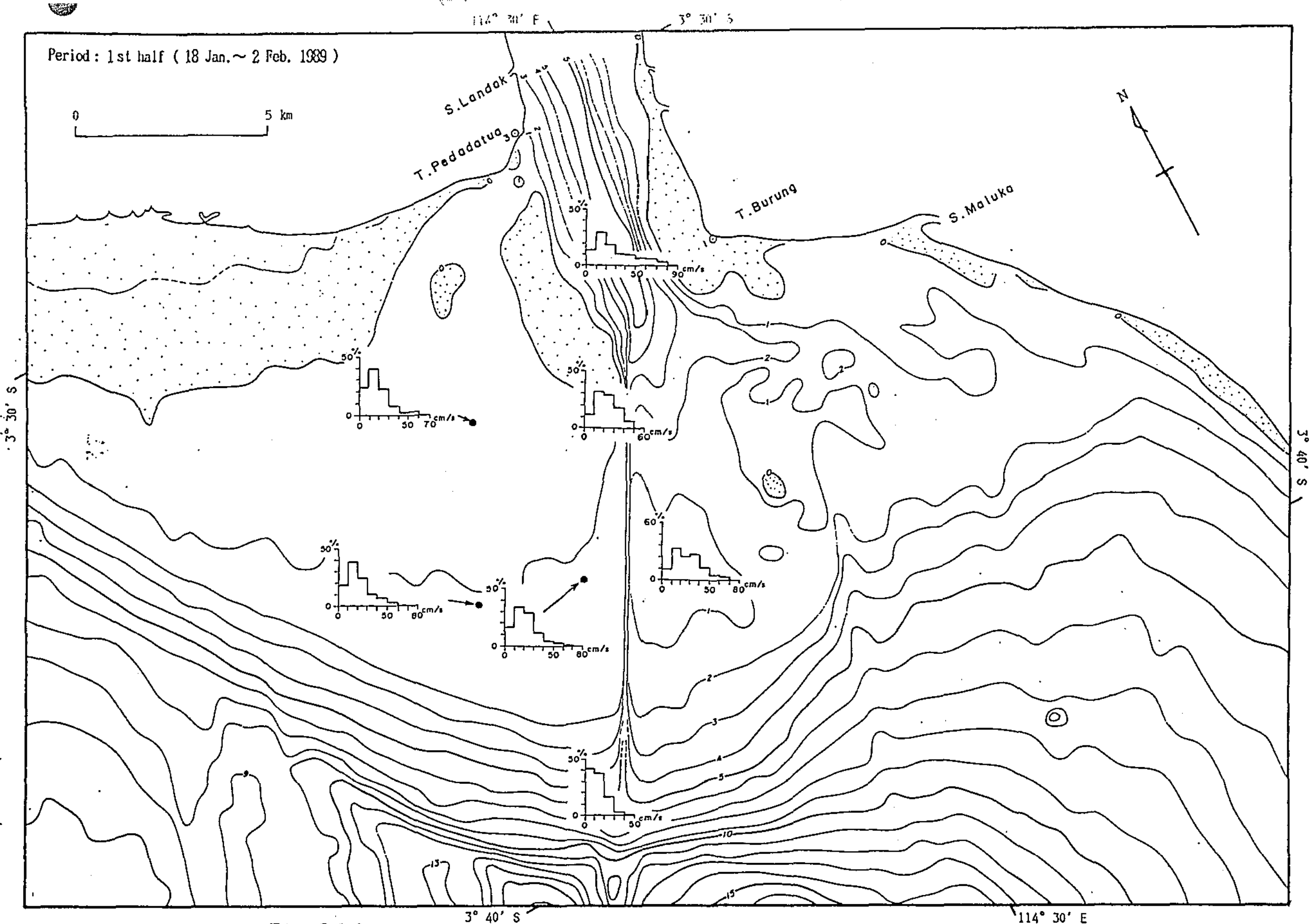


Fig. 5.3.2 - 2(3) Frequency Distribution of Current Velocity (2nd General Survey)

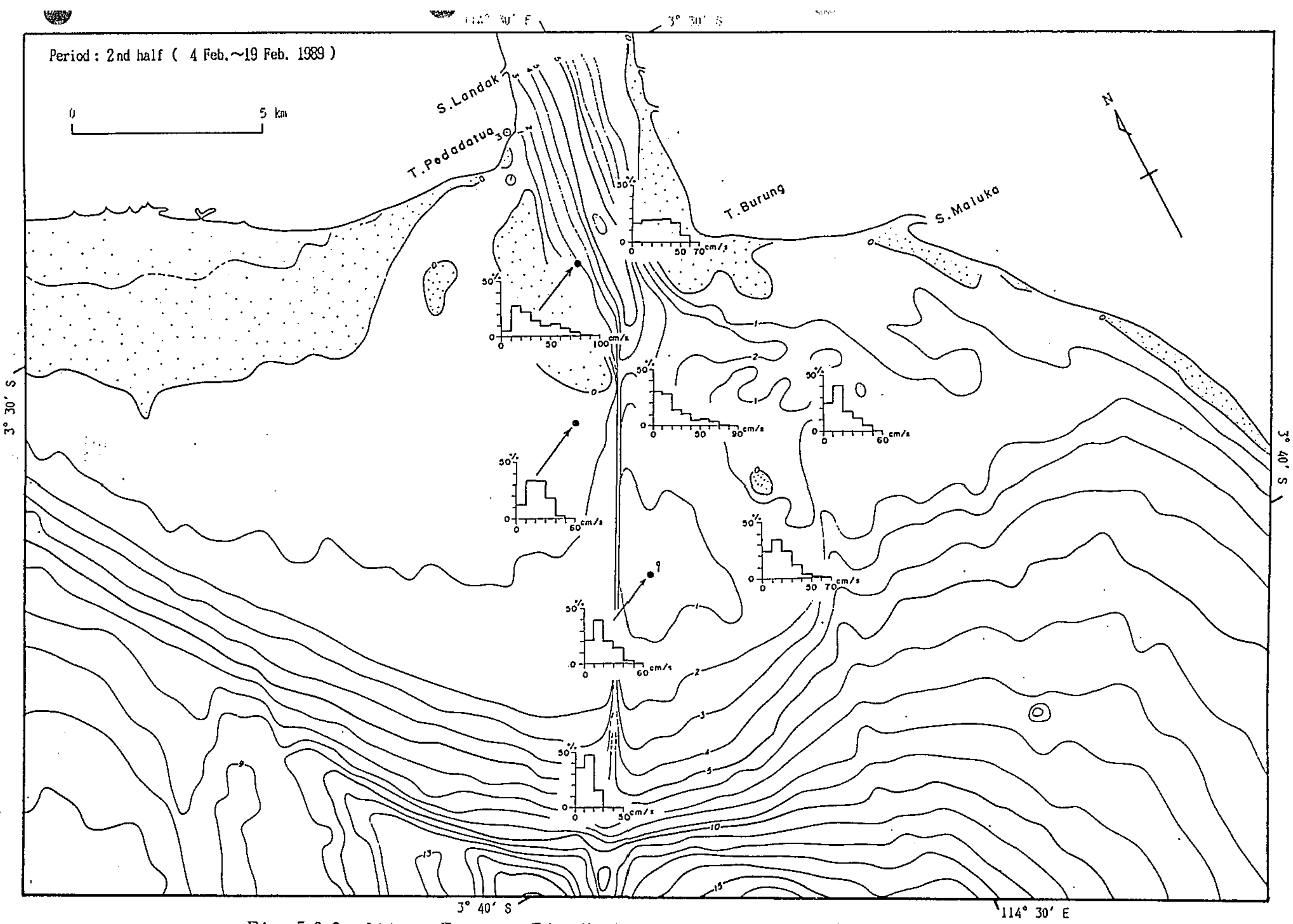


Fig. 5.3.2 − 2(4) Frequency Distribution of Current Velocity (2nd General Survey)

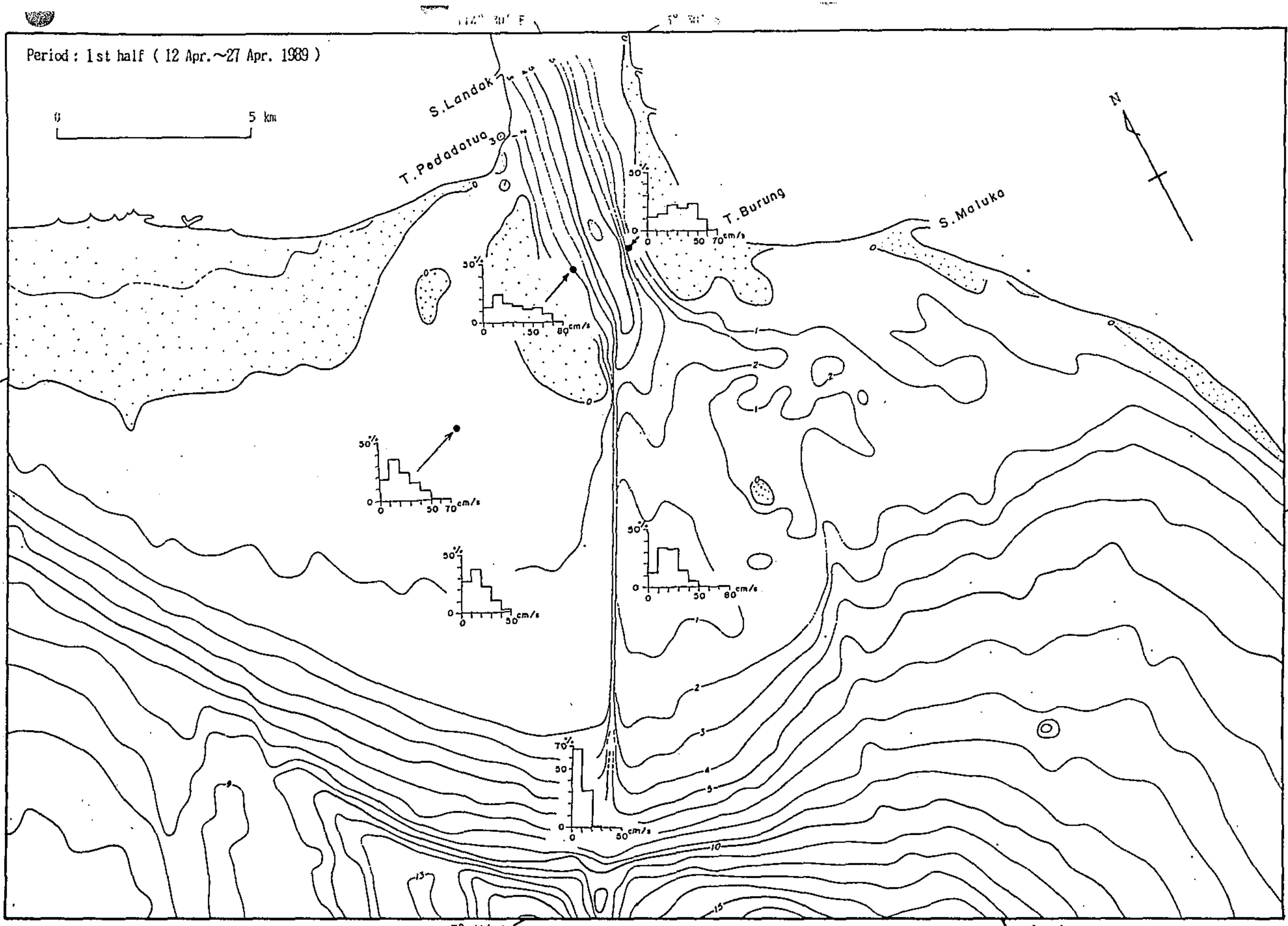


Fig. 5.3.2 − 2(5) Frequency Distribution of Current Vefocity (3rd General Survey)

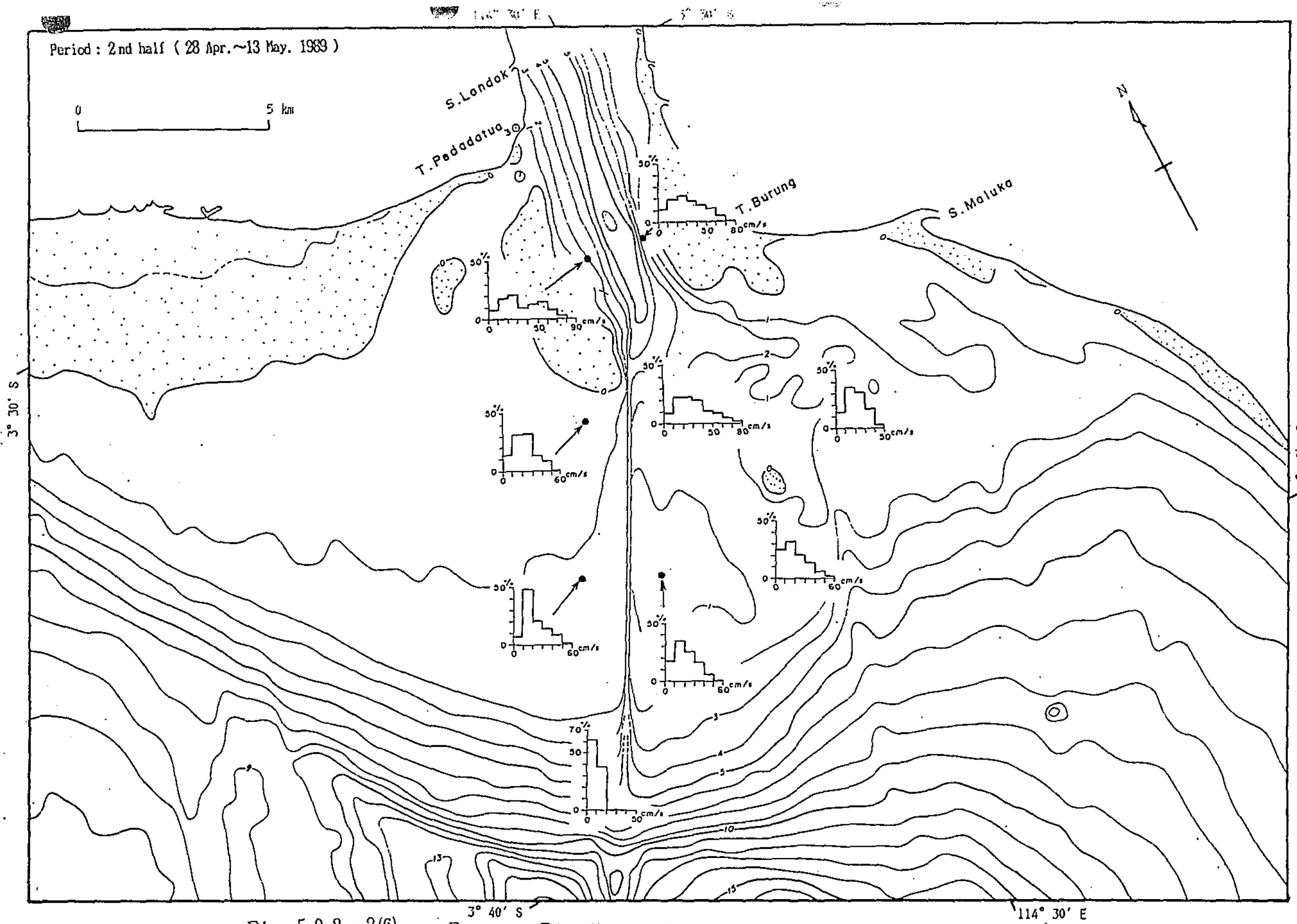


Fig. 5.3.2－2(6) Frequency Distribution of Current Velocity (3rd General Survey)

2) Tidal Currents

St.4 where is apt to effect strongly by the river current in the mouth of the Barito river and St.2 where locates closely to the offing end of the Access Channel were selected for the purpose of obtaining tidal current condition. And type of tidal current was obtained by using the aforementioned method. The process and results were showed as under.

- 1st stage(Dry season)

$$St.2 \quad : \frac{K1 + O1}{M2 + S2} = 0.98$$

$$St.4 \quad : \frac{K1 + O1}{M2 + S2} = 4.35$$

- 2nd stage(Rainy season)

$$St.2 \quad : \frac{K1 + O1}{M2 + S2} = 1.03$$

$$St.4 \quad : \frac{K1 + O1}{M2 + S2} = 2.31$$

- 3rd stage(Intermediate season)

$$St.2 \quad : \frac{K1 + O1}{M2 + S2} = 1.10$$

$$St.4 \quad : \frac{K1 + O1}{M2 + S2} = 2.01$$

According to the results, type of tidal currents at St.2 showed the mixed type with rather near diurnal tide. As aforementioned in chapter of tidal currents, this type was similar to the type in the offing area. The type at St.4 showed diurnal tide.

Principal four tidal constants at St.2 and St.4 are shown as under.

St.		2				4			
stage		K1	O1	M2	S2	K1	O1	M2	S2
1st	Amp.(cm)	15.0	8.2	18.7	5.0	28.6	14.3	5.7	4.2
	Phase(°)	280	233	75	340	266	203	144	93
2nd	Amp.(cm)	13.9	8.7	18.5	3.5	27.3	11.7	12.0	4.9
	Phase(°)	276	229	78	43	286	230	88	292
3rd	Amp.(cm)	12.9	8.2	16.2	2.9	26.2	15.9	14.4	6.5
	Phase(°)	264	315	68	245	291	233	112	26

Tidal current with K1 and M2 component current at St.2 was dominant and the amplitudes for K1 and M2 were 13-15cm and 16-19cm, respectively, without big change among seasons. As for St.4, K1 component current was dominant with amplitude 26-29cm and M2 component current was rather small with amplitude 6-14 cm.

Followings were described about horizontal distribution of current ellipses of K1 by using Fig.5.3.2-3.

Principal axis (Long axis) shows proceeding direction of K1 tidal component current.
That is, in case of east side area of the Access Channel, it showed N - S in direction and agreed with stream axis of the Barito river.
However, in case of west side area of the Access Channel, it seemed that K1 tidal component current entered to avoid sand bar of west side in anti-clock wise. Similar pattern can be seen in each season.

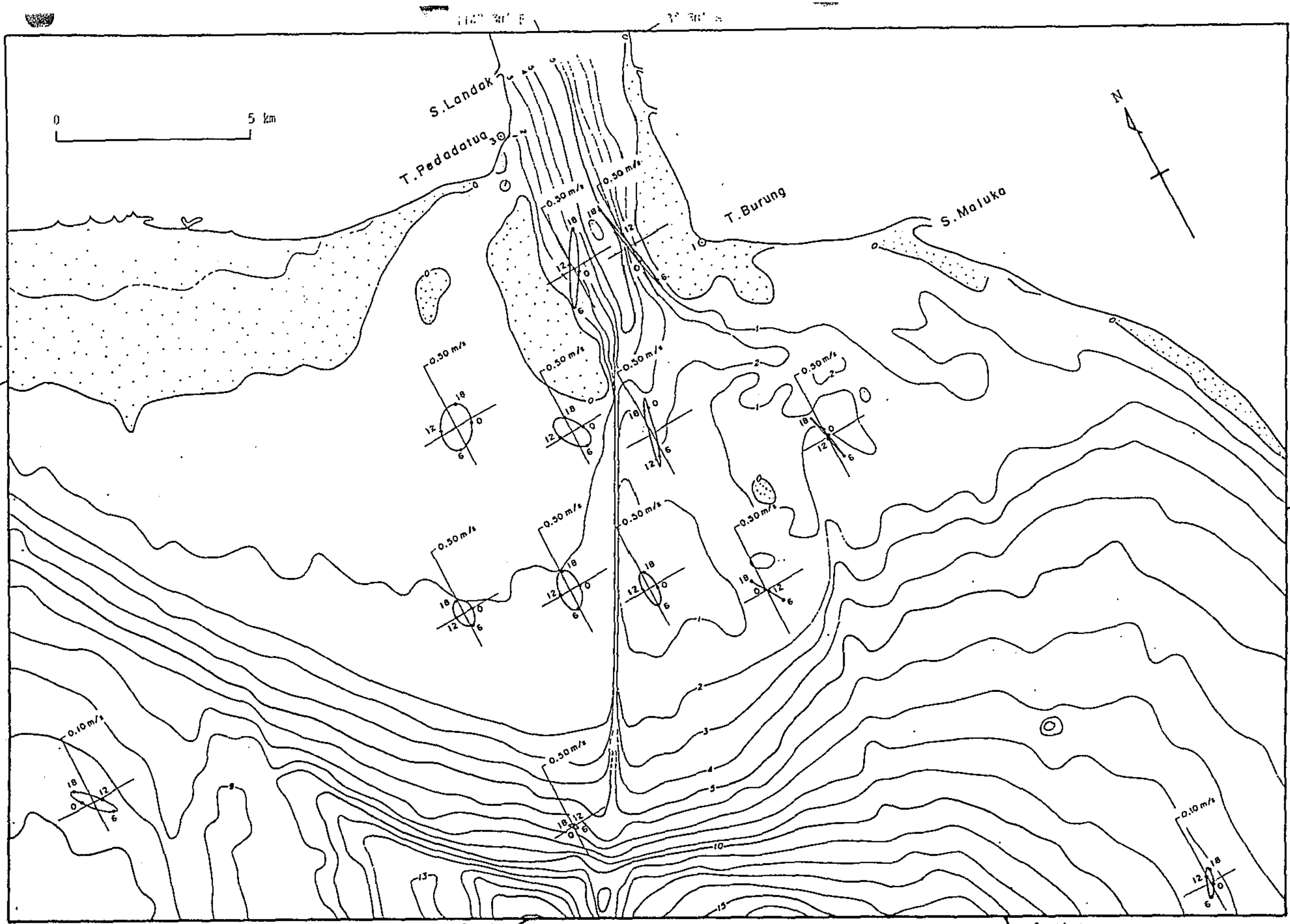


Fig. 5.3.2－3(1)　Current Ellipses　(K_1 : 1st General Survey)

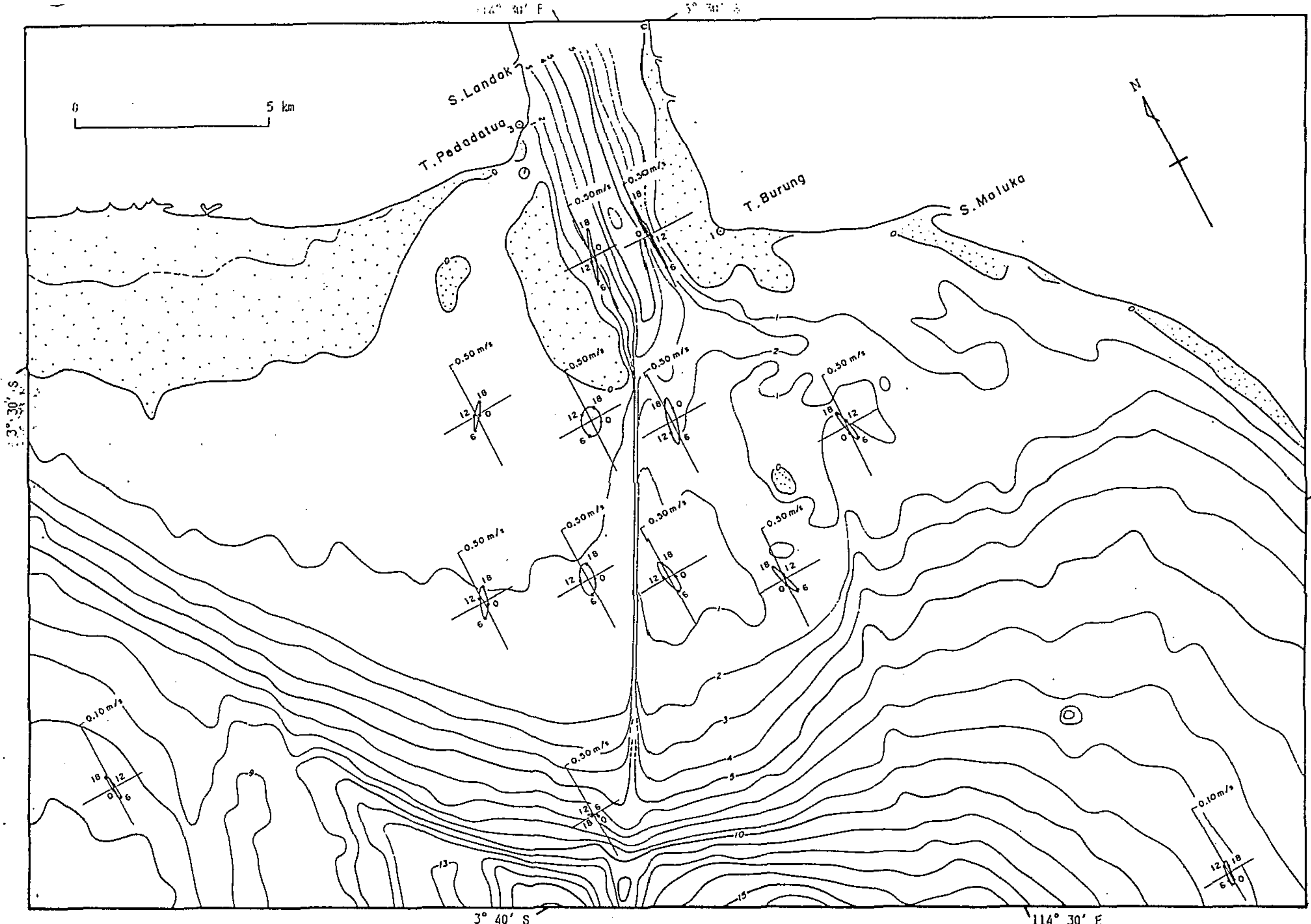


Fig. 5.3.2 − 3(2) Current Ellipses (K_1 : 2nd General Survey)

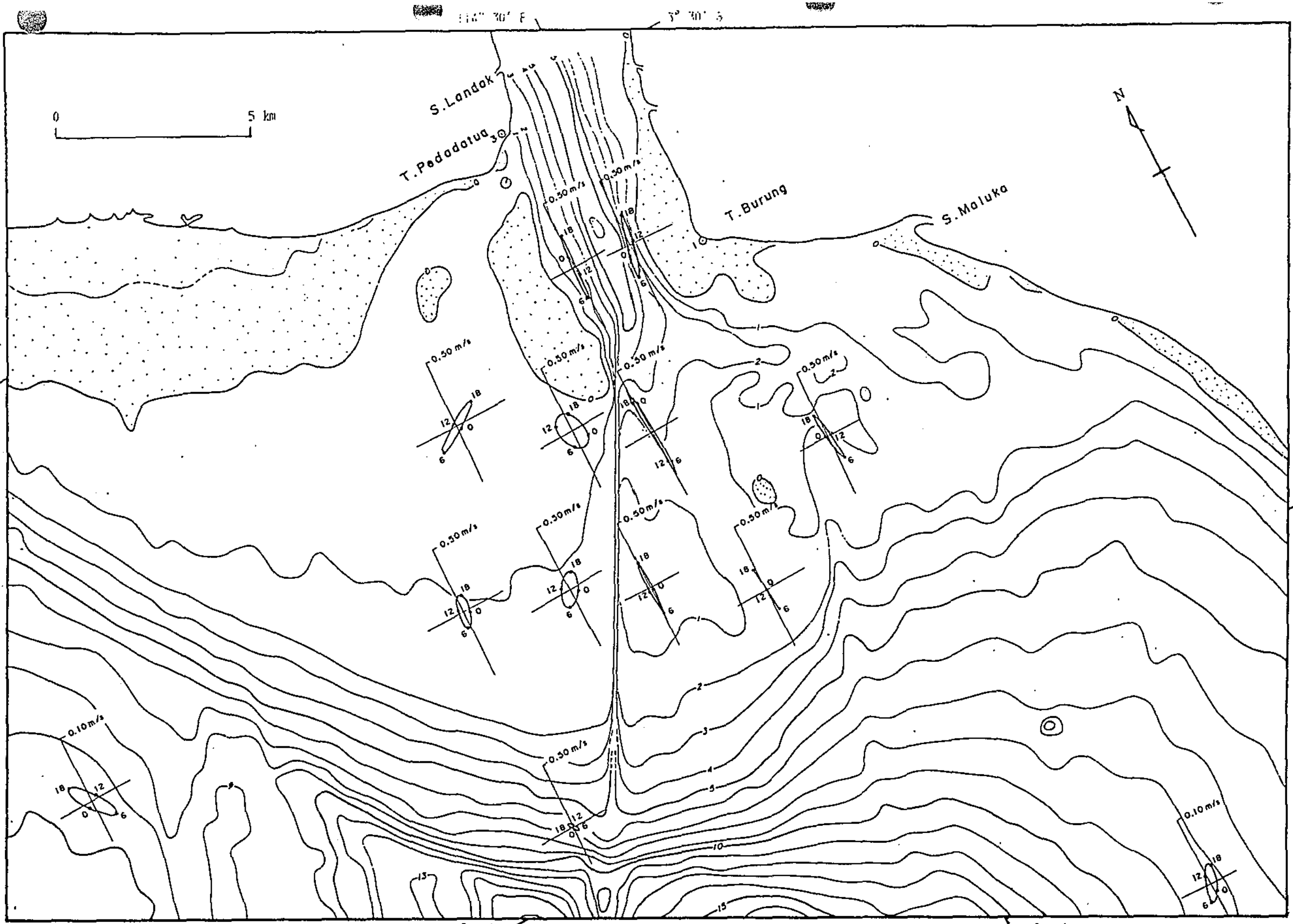


Fig. 5.3.2 − 3(3) Current Ellipses (K_1 : 3rd General Survey)

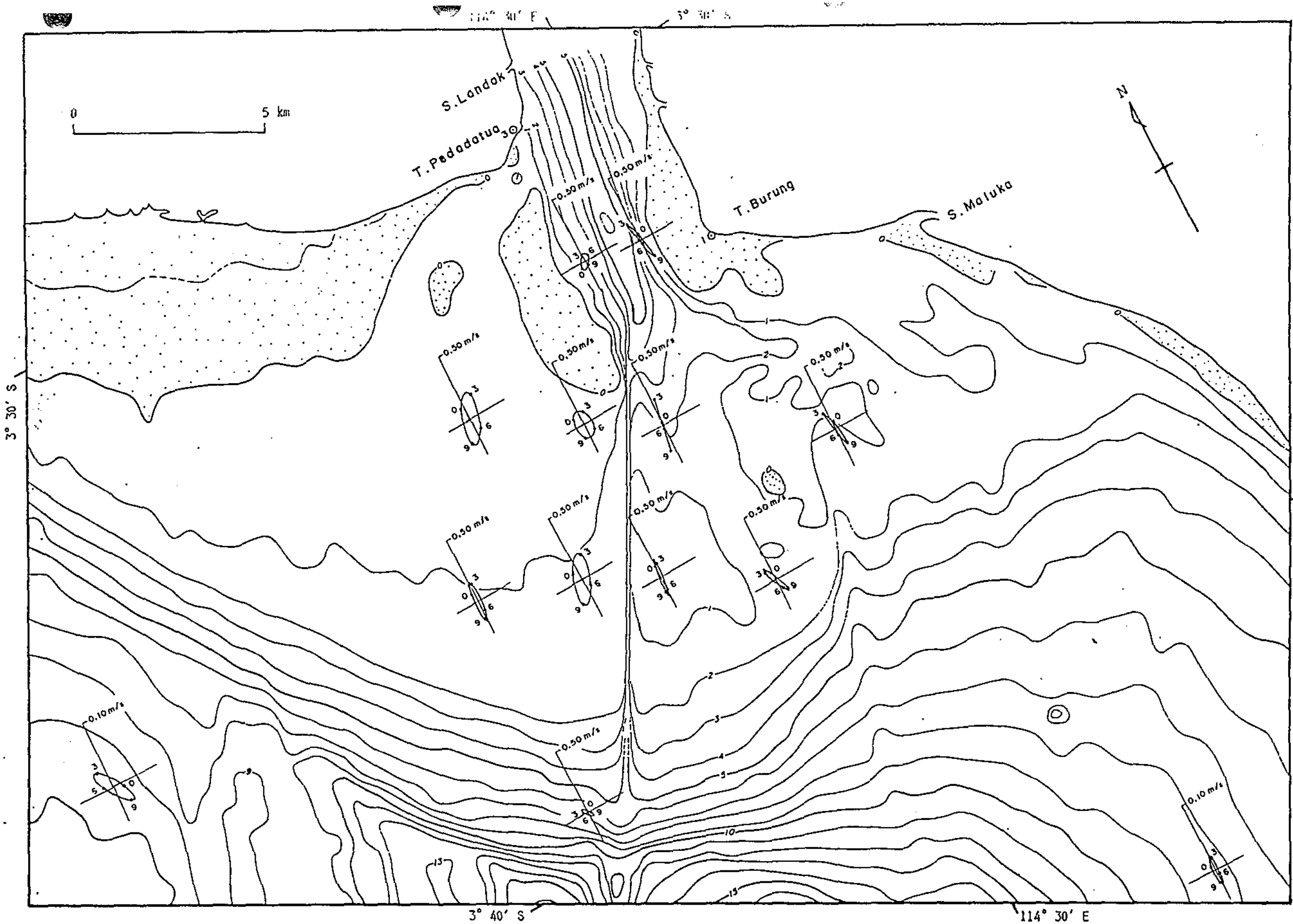


Fig. 5.3.2 − 3(4) Current Ellipses (M_2 : 1st General Survey)

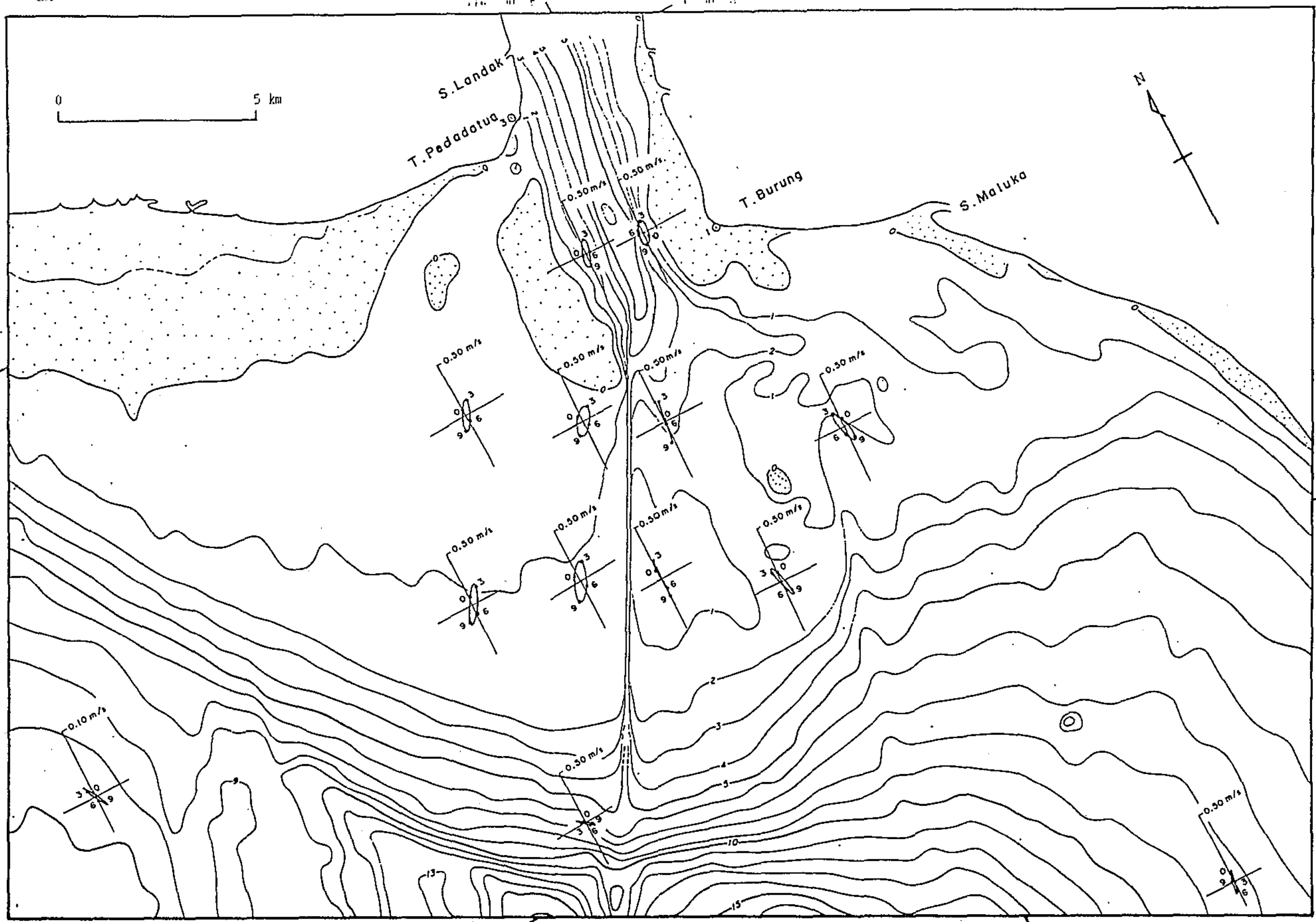


Fig. 5.3.2 − 3(5) Current Ellipses (M_2 : 2nd General Survey)

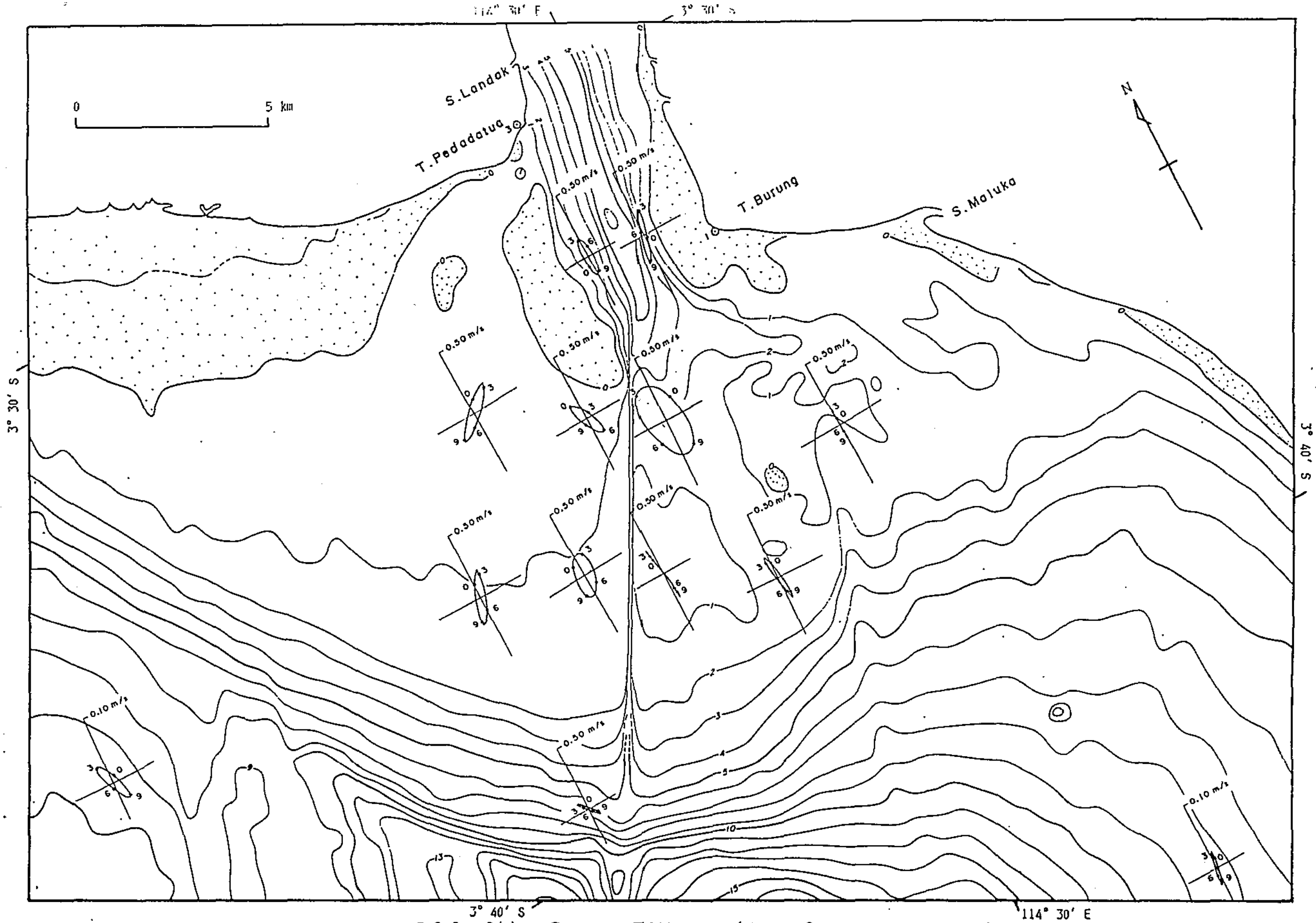


Fig. 5.3.2 − 3(6) Current Ellipses (M_2 : 3rd General Survey)

3) Mean Current

Distribution of mean current was shown in Fig. 5.2.3-4. Paterns of mean current changed by season.
A patern in 1st stage showed that water river deviated largely to west side and a patern in 2nd stage showed a tendency in going directly down to south and a patern in 3rd stage seemed that river water confluenced from west side and east side on the Access Channel.

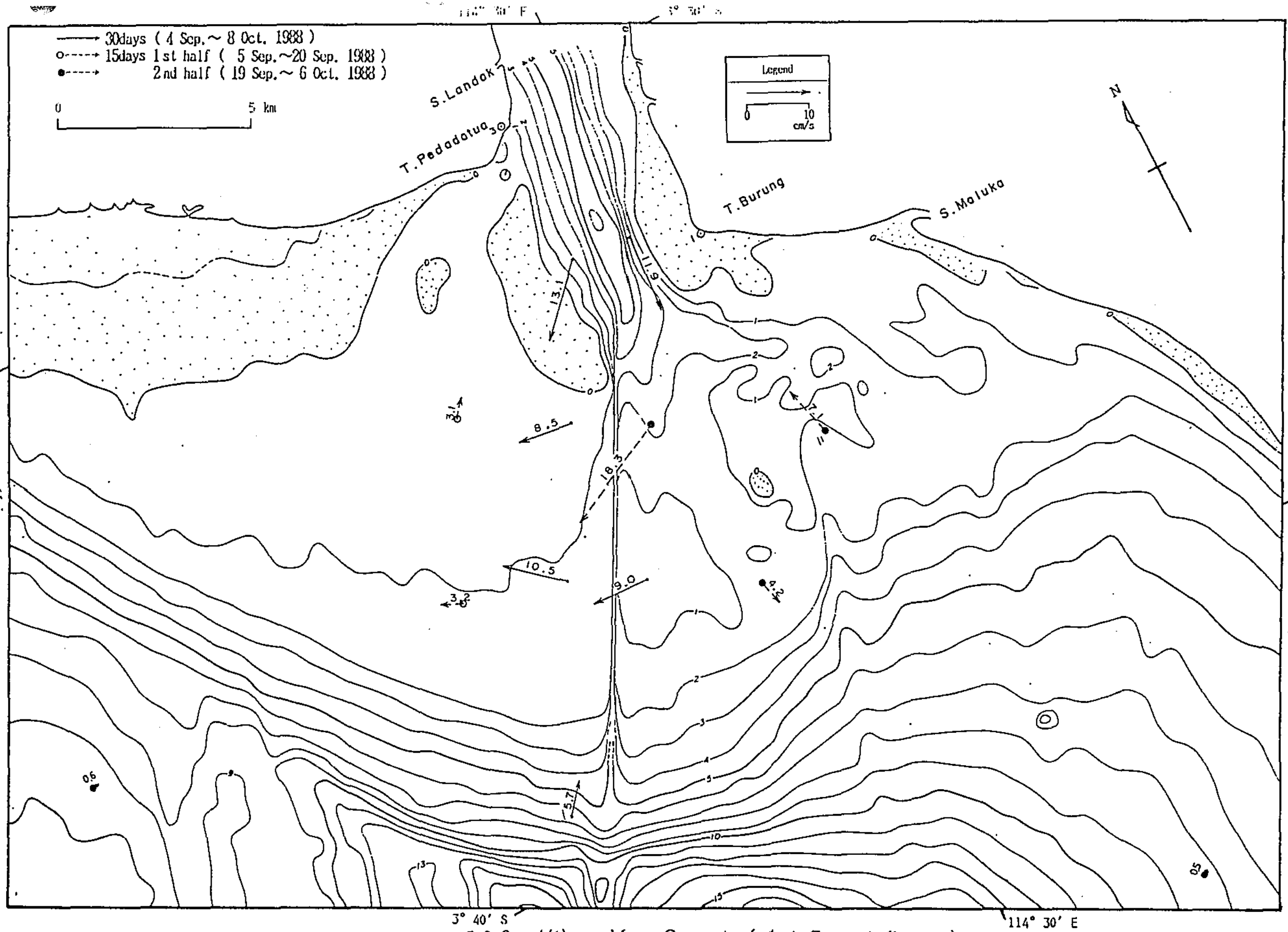


Fig. 5.3.2 - 4(1) Mean Current (1st General Survey)

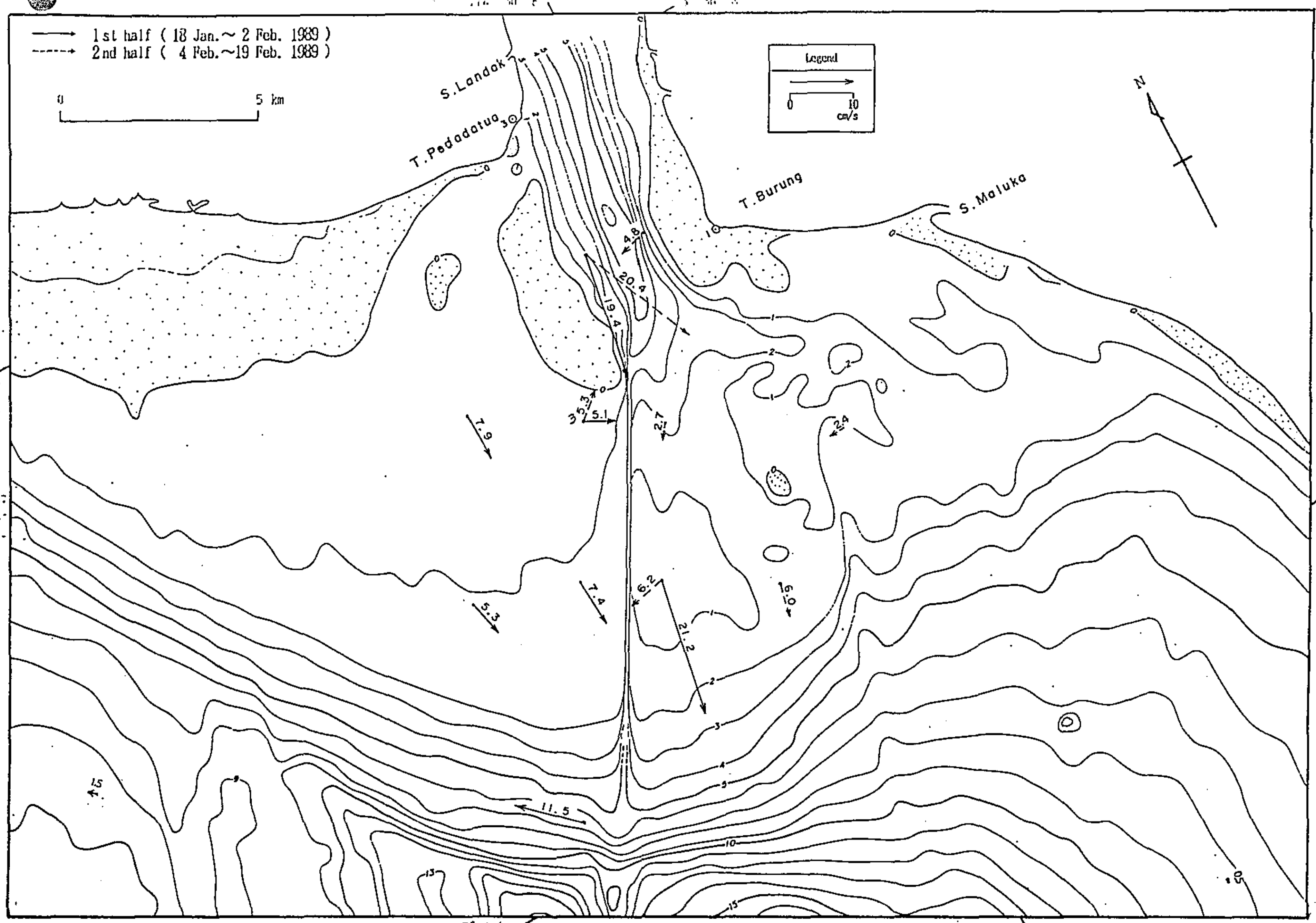


Fig. 5.3.2－4(2)　Mean Current (2nd General Survey)

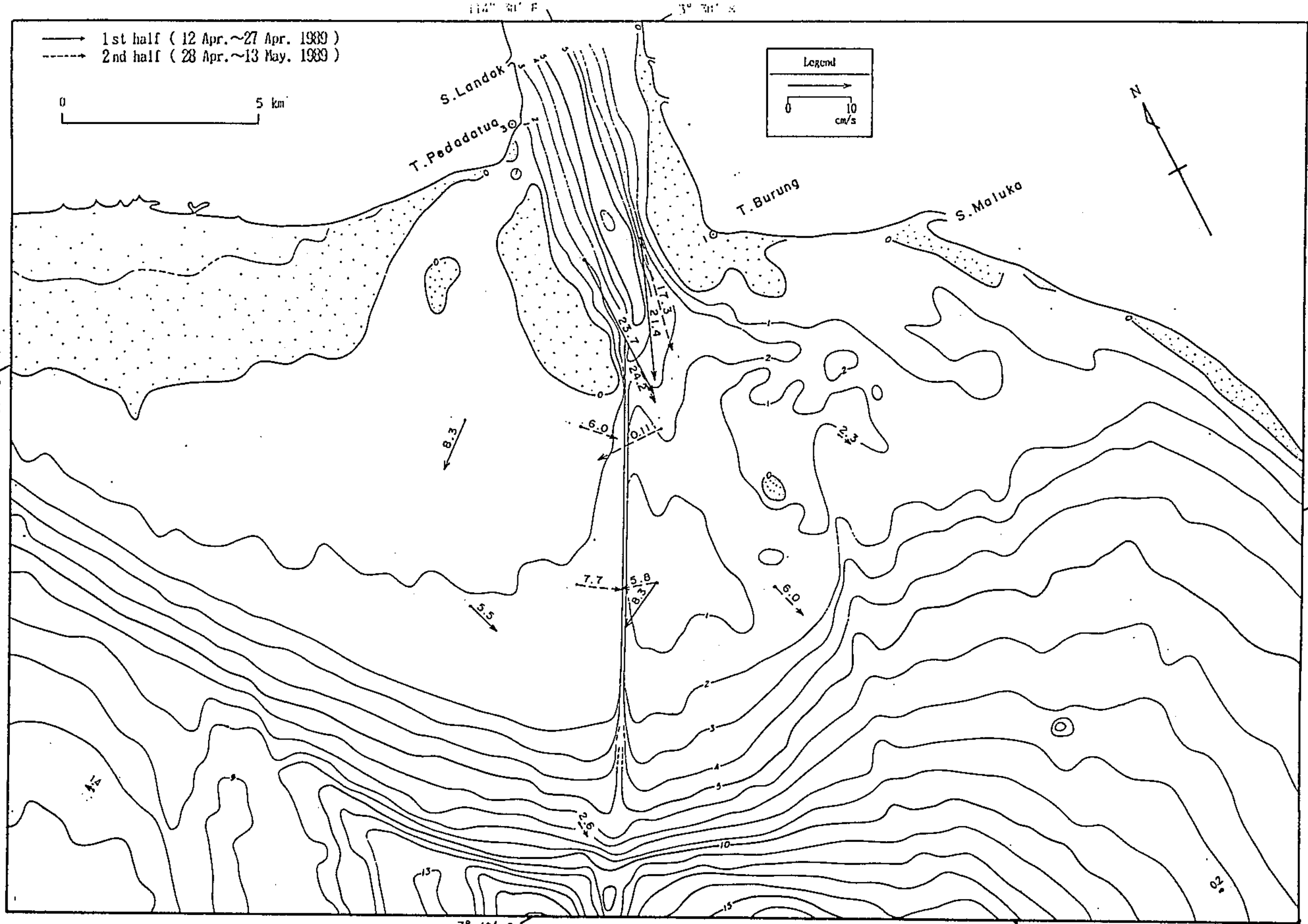


Fig. 5.3.2－4(3) Mean Current (3rd General Survey)

5.3.3 Buoy Tracking

Buoy trtacking surveys were carried out during each General Survey by means of pursueing four floats for eight hours per a day in three continuous days in each General Survey. Survey schedule are shown in table 5.3.3-1.

Locus of floats every season were comprised to study the patterns of current around the Access Channel and were shown in Fig. 5.3.3-1.

- 1st stage

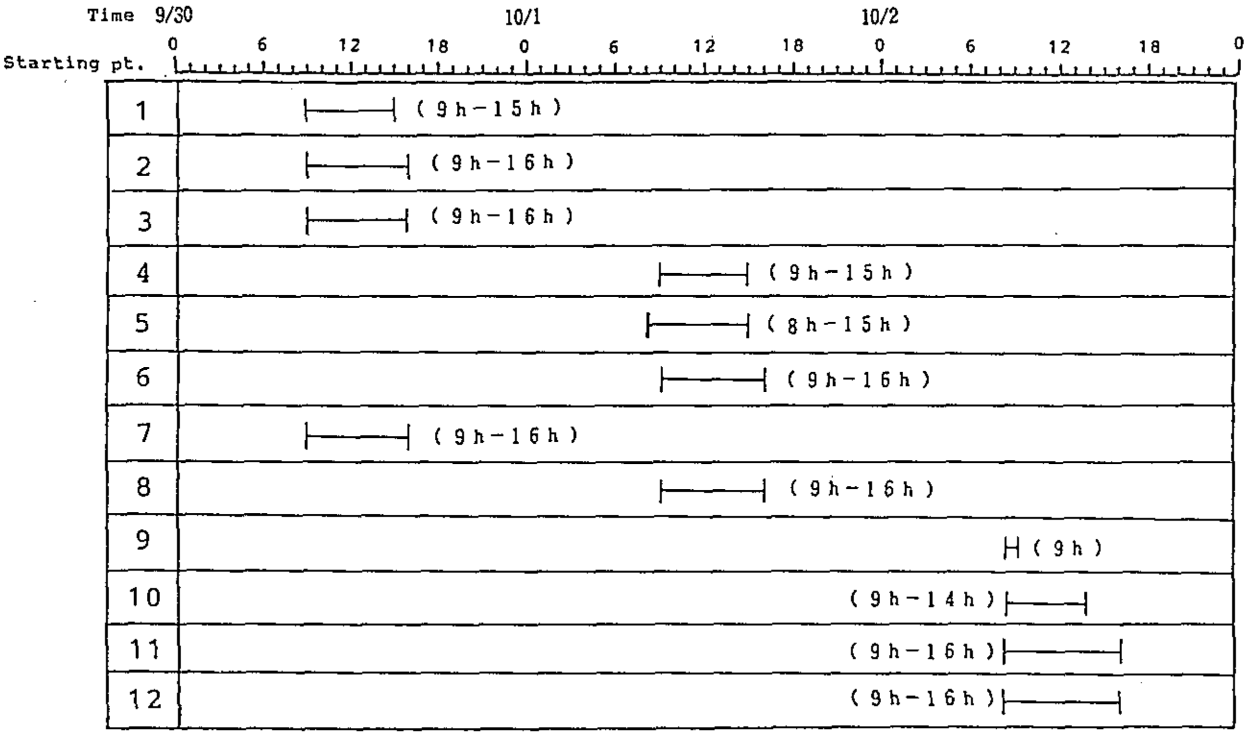
Pursueing time zone was ebb tide and floats drifted to the farthest area. Examining the locus of floats, after floats, except three floats, departured start line and converged to there among shoales then diverged and drifted away in a radial. It was considered that this pattern showed a typical type which river water diffused in shallow sea area.

- 2nd stage

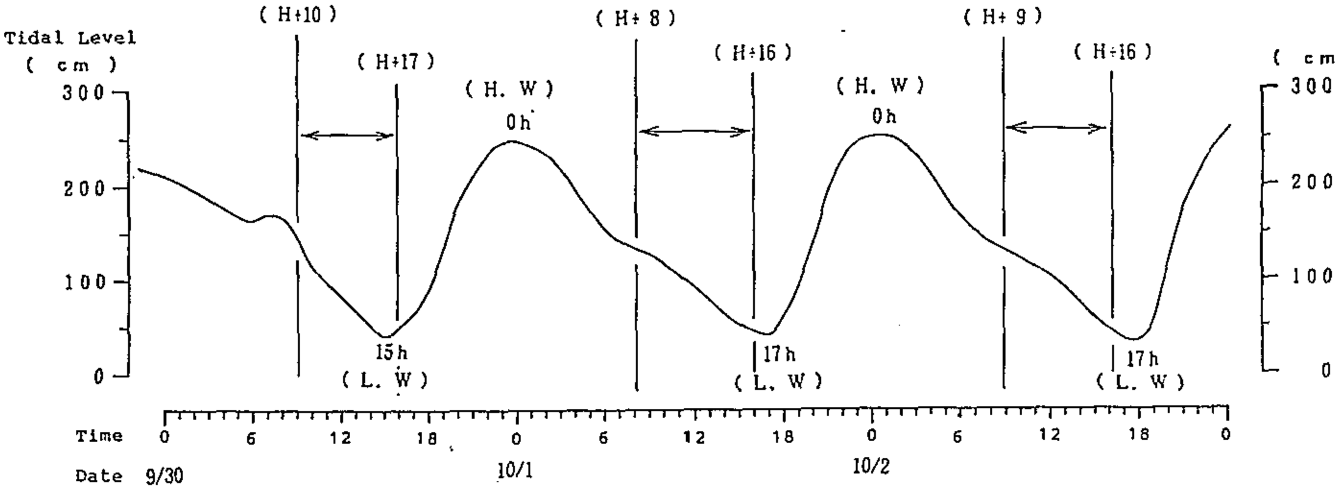
Pursueing time zone was from flood to high water and locus of floats showed a pattern of streaming up in the river.

- 3rd stage

Pursueing time zone was from flood to ebb tide via high water. Therefore locus of floats obtained an appearance of alternating in current direction.

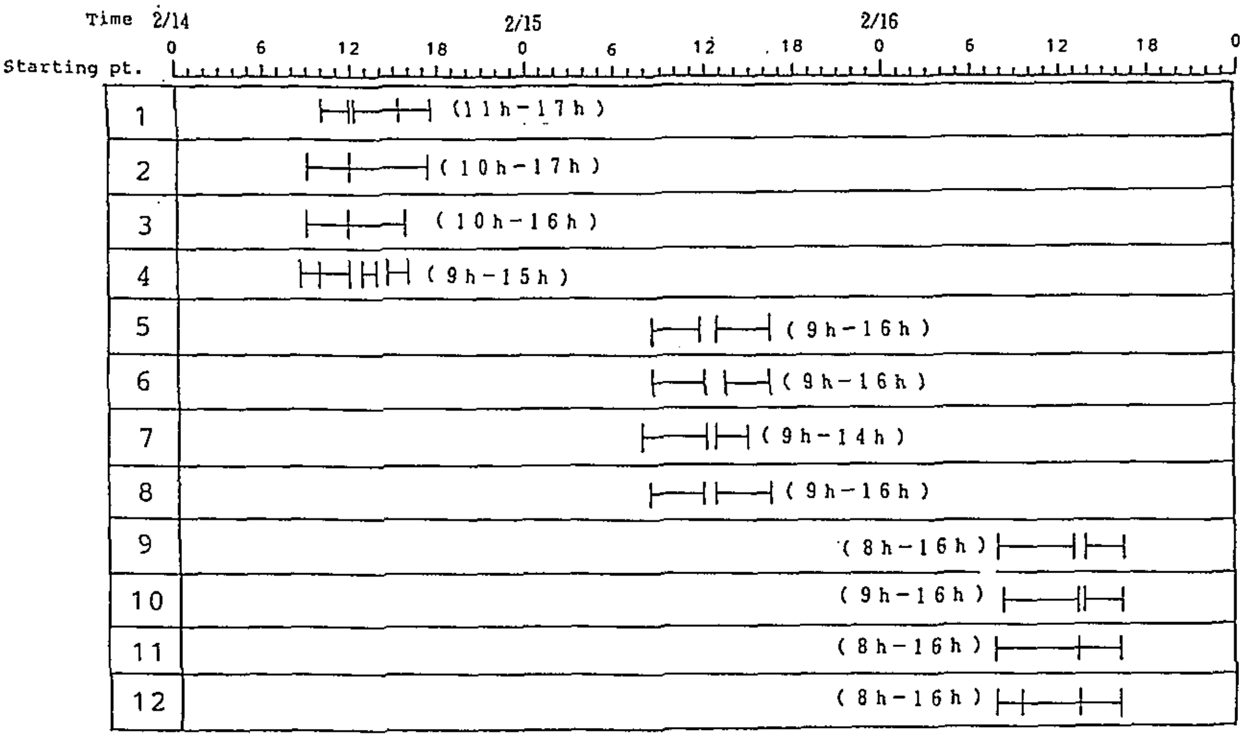


Note: Hours in ( ) shows duration of tracking for each float.

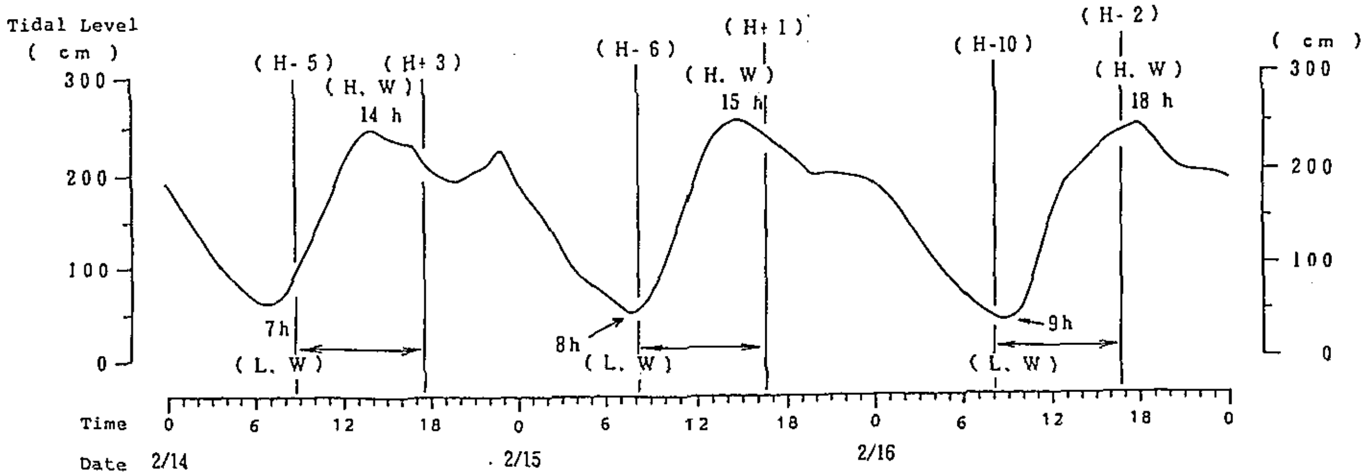


Note: ├──┤ shows duration of buoy tracking survey and
←→ shows duration for adopted data.
(H. W)···High Water
(L. W)···Low Water
(H+1) or (L+1)···1hour after H. W or L. W
(H−1) or (L−1)···1hour before H. W or L. W

Table. 5.3.3−1(1) Executed Buoy Tracking Survey (1st Stage)

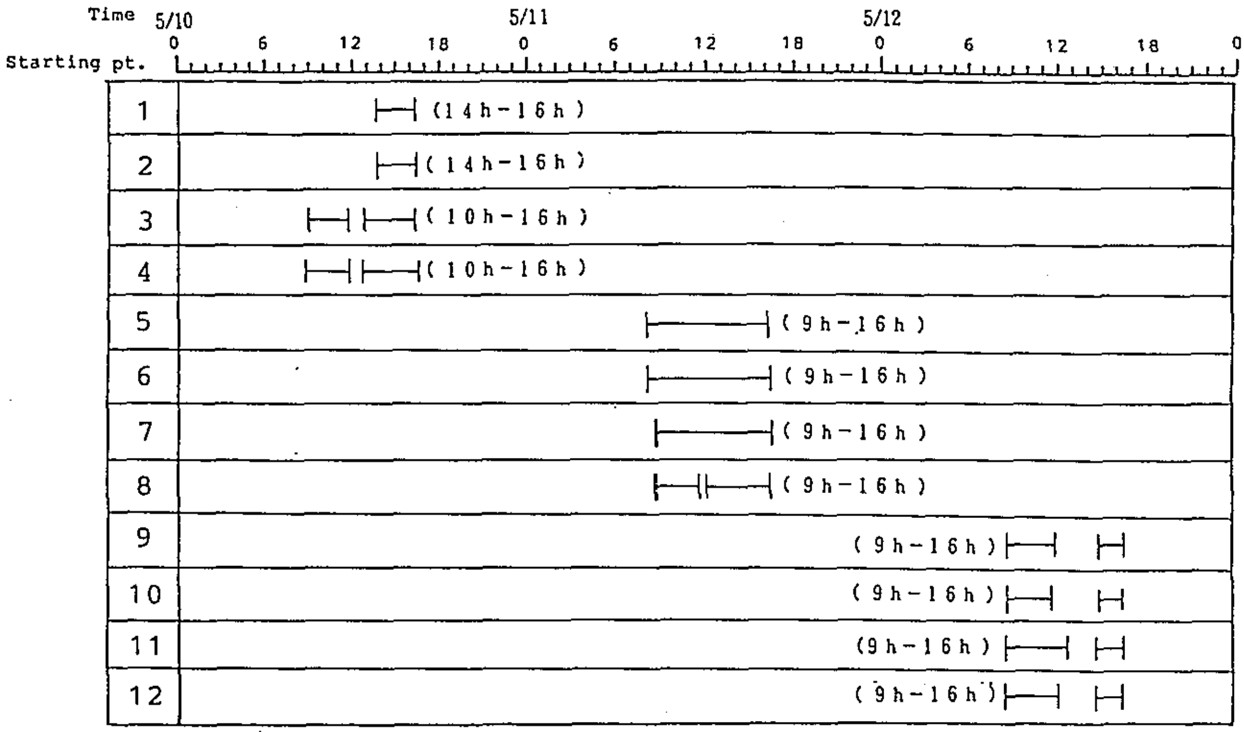


Note: Hours in ( ) shows duration of tracking for each float.

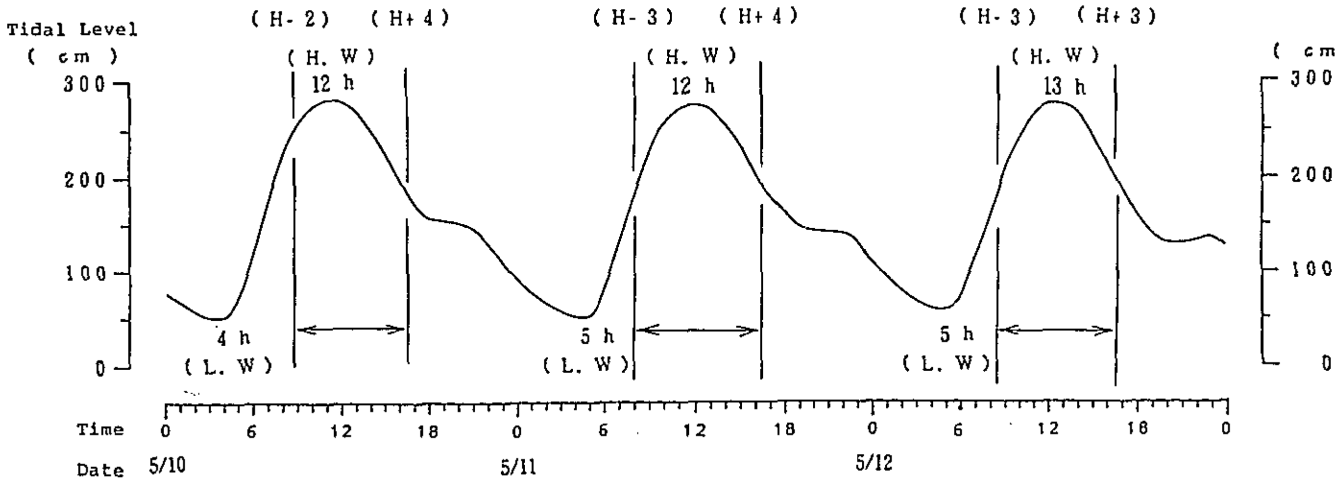


Note: ├──┤ shows duration of buoy tracking survey and
←──→ shows duration for adopted data.
(H W)···High Water
(L W)···Low Water
(H+1) or (L+1)···1hour after H W or L W
(H-1) or (L-1)···1hour before H W or L W

Table. 5.3.3-1(2) Executed Buoy Tracking Survey (2nd Stage)



Note: Hours in ( ) shows duration of tracking for each float.



Note: ├──┤ shows duration of buoy tracking survey and
←──→ shows duration for adopted data.
(H. W)···High Water
(L. W)···Low Water
(H+1) or (L+1)···1hour after H. W or L. W
(H−1) or (L−1)···1hour before H. W or L. W

Table. 5.3.3−1(3) Executed Buoy Tracking Survey (3rd Stage)

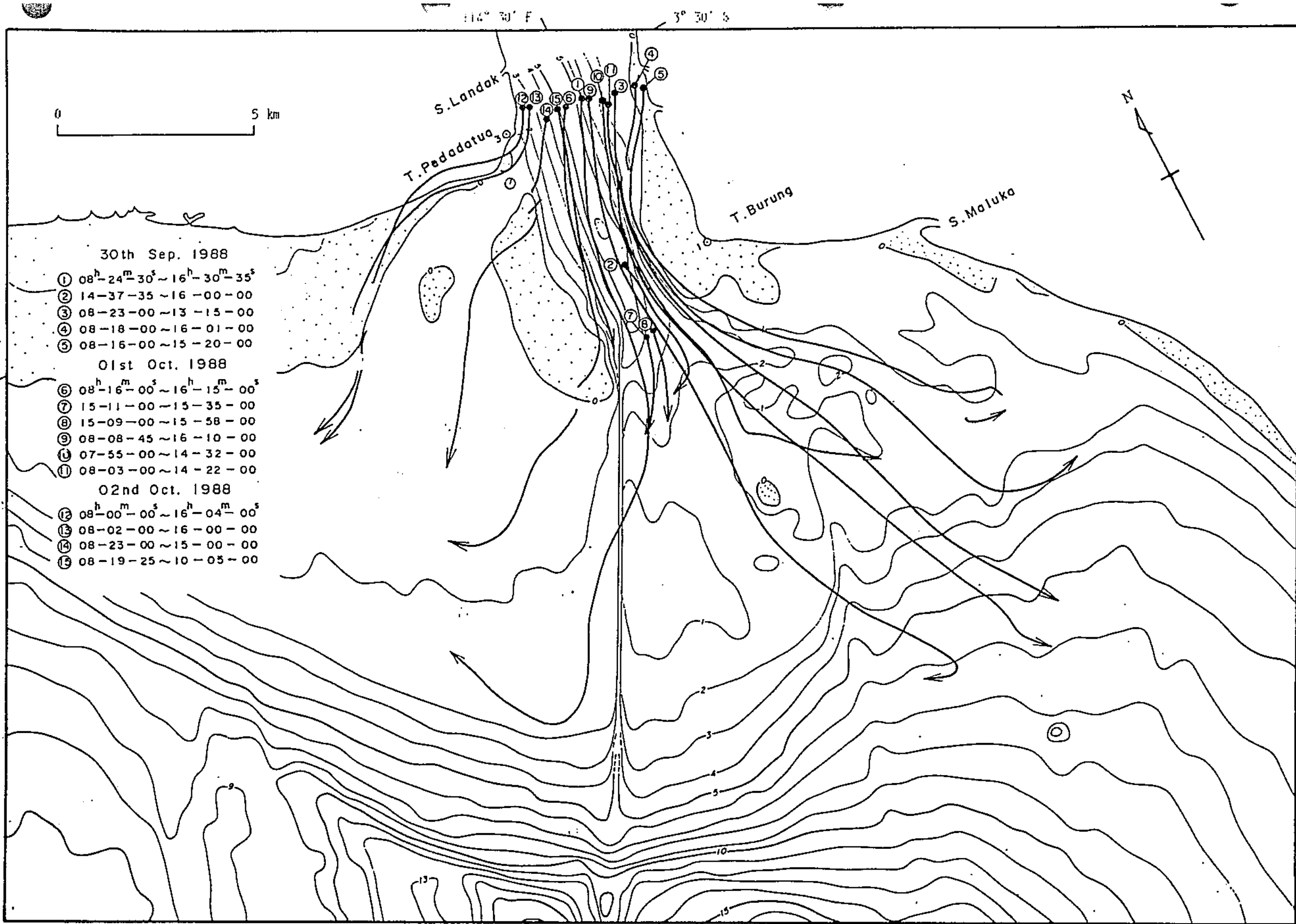


Fig. 5.3.3 − 1(1) Locus of Floats

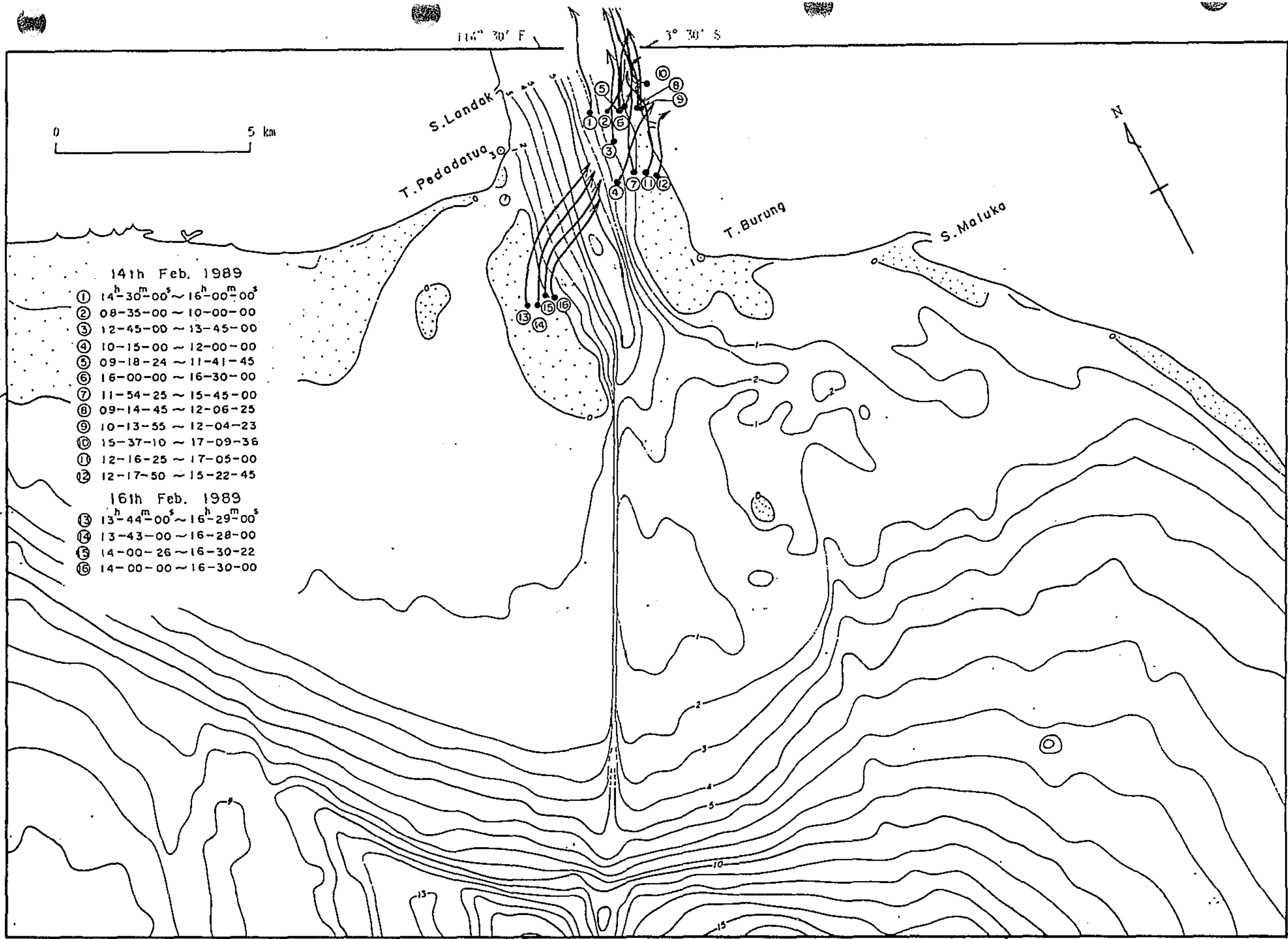


Fig. 5.3.3 − 1(2) Locus of Floats

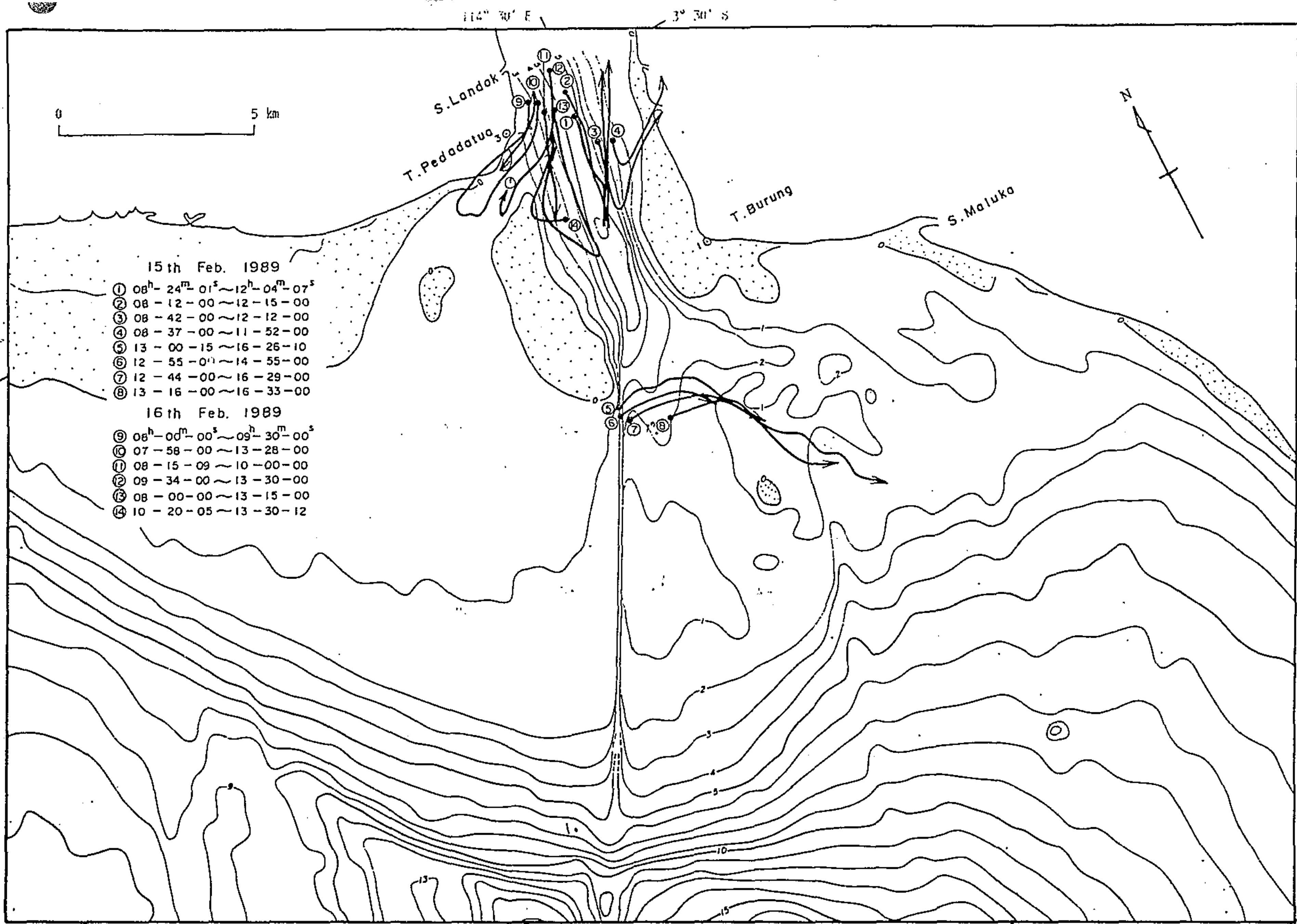


Fig. 5.3.3 − 1(3) Locus of Floats

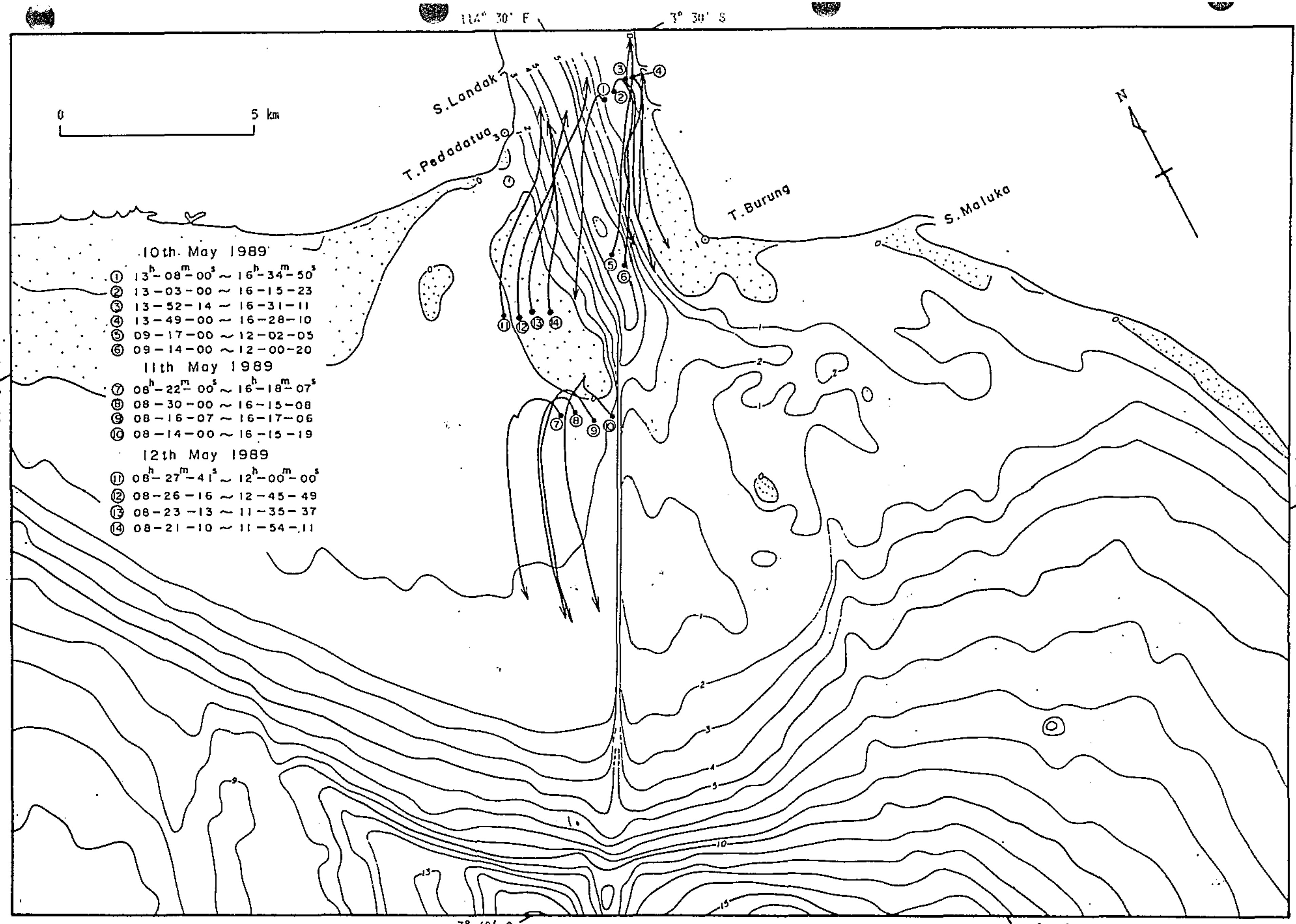


Fig. 5.3.3 − 1(4) Locus of Floats

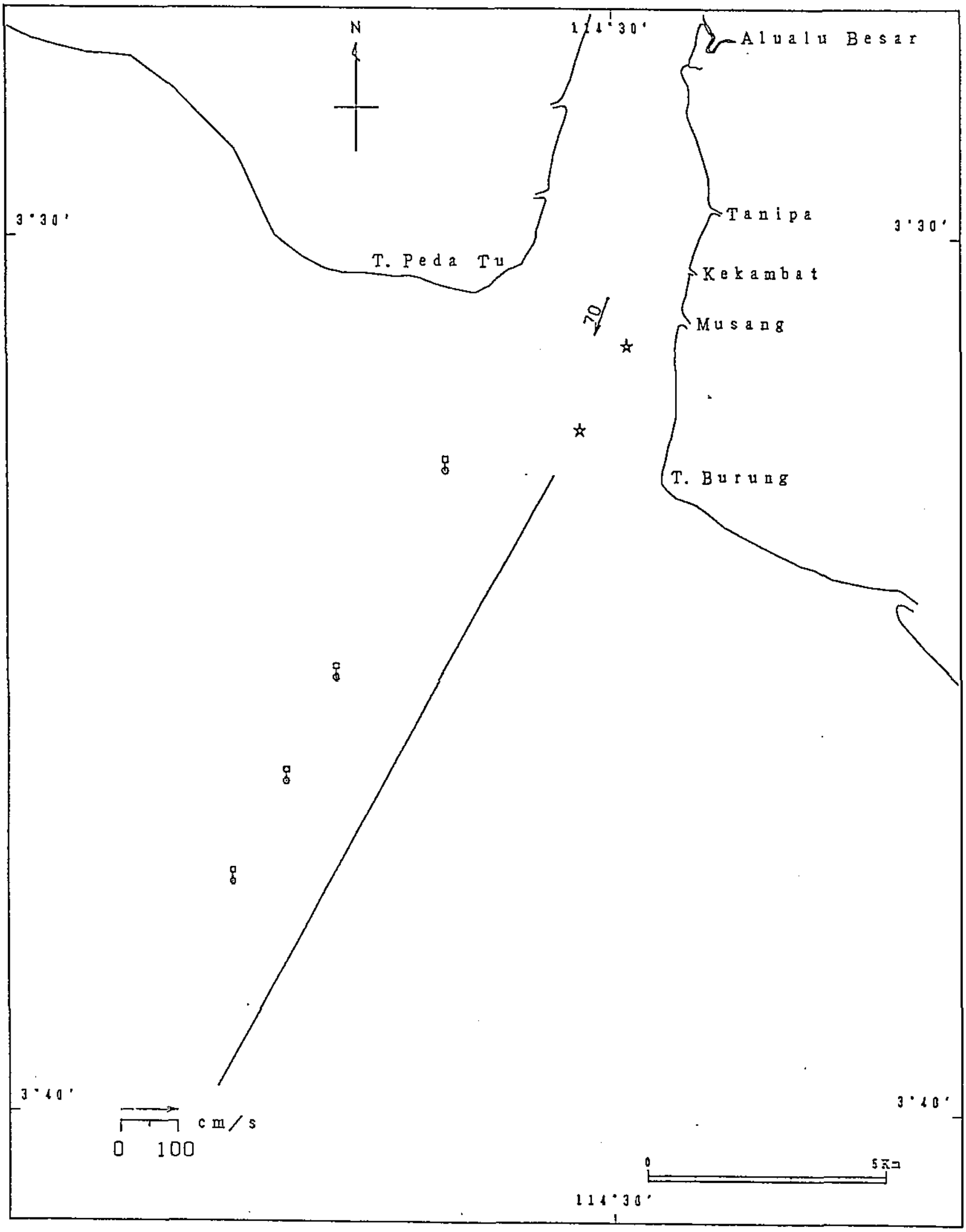


Fig. 5.3.3－2(1) Current Obtained by Buoy Tracking Survey (8 hours after H.W)
(1st General Survey)

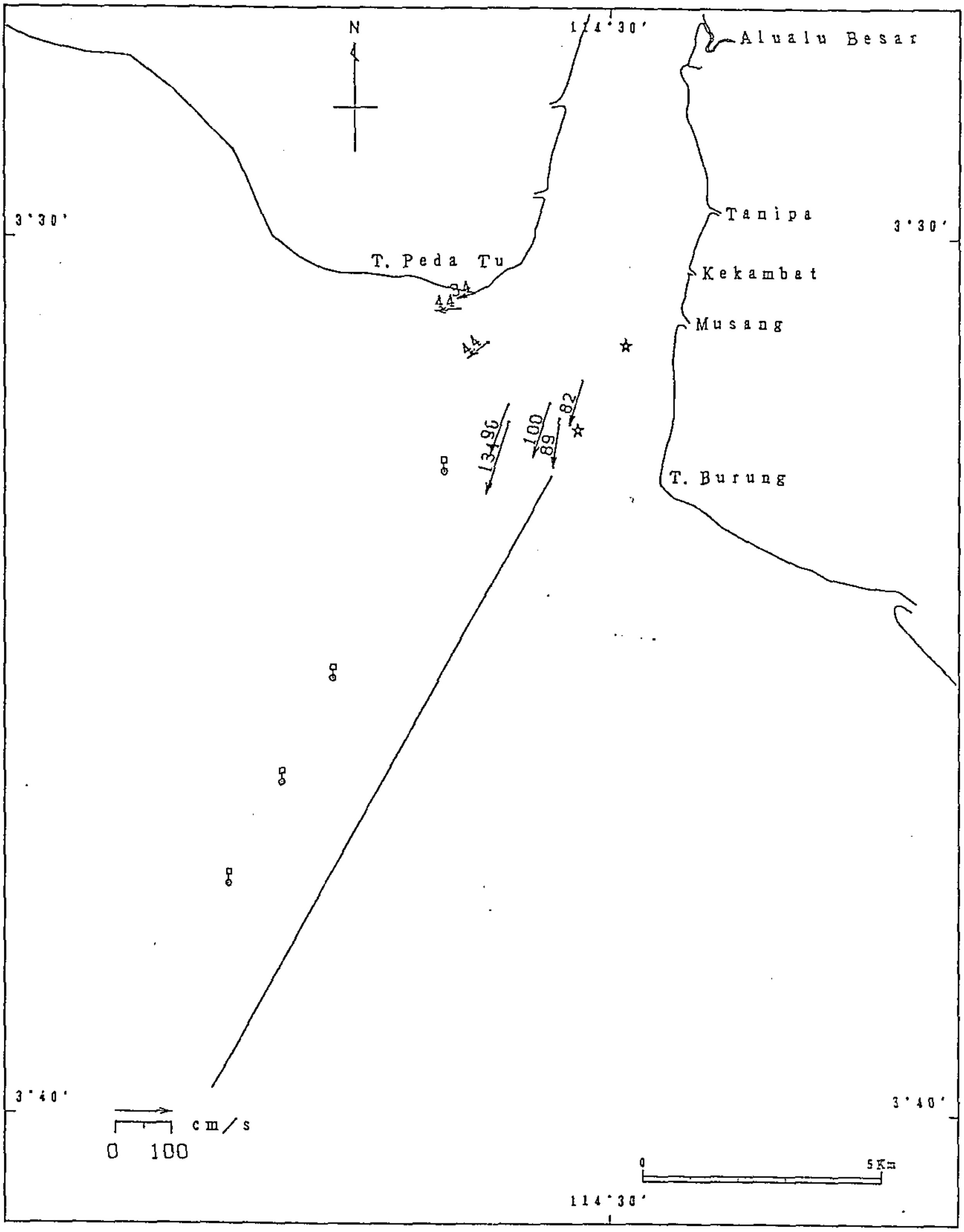


Fig. 5.3.3－2(2) Current Obtained by Buoy Tracking Survey (9 hours after H.W)
(1st General Survey)

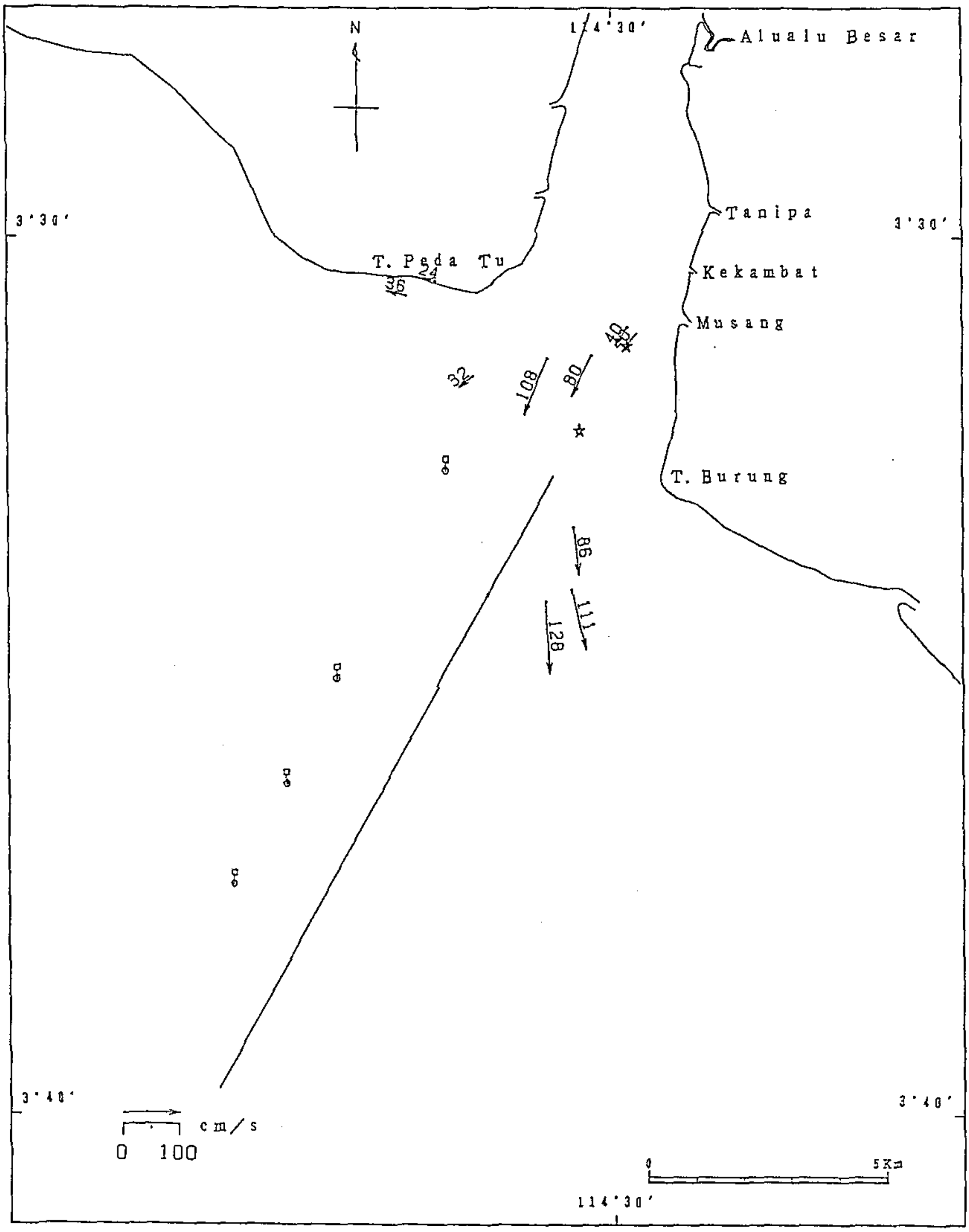


Fig. 5.3.3 − 2 (3) Current Obtained by Buoy Tracking Survey (10 hours after H.W)
(1st General Survey)

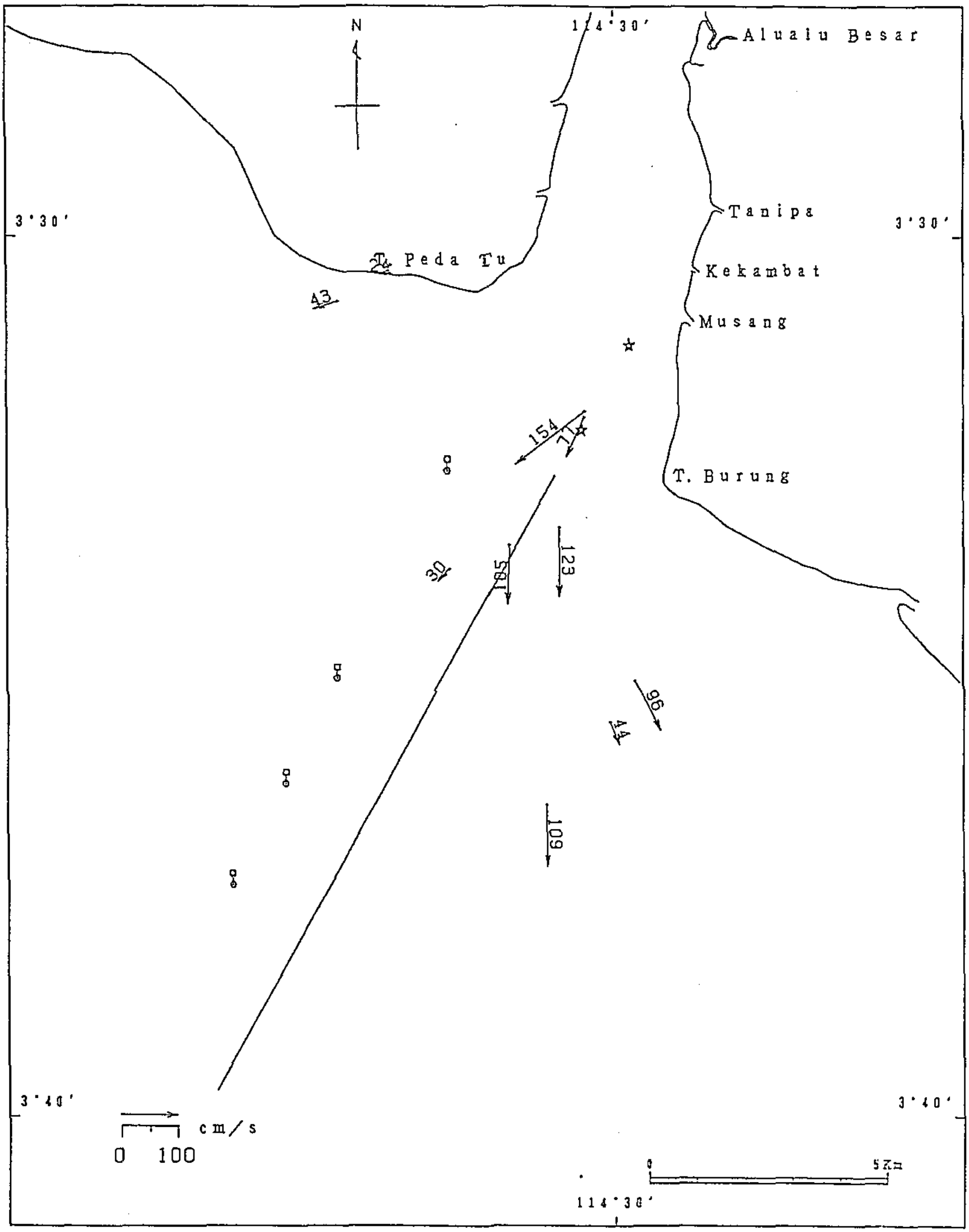


Fig. 5.3.3 - 2 (4) Current Obtained by Buoy Tracking Survey (11 hours after H.W)
(1st General Survey)

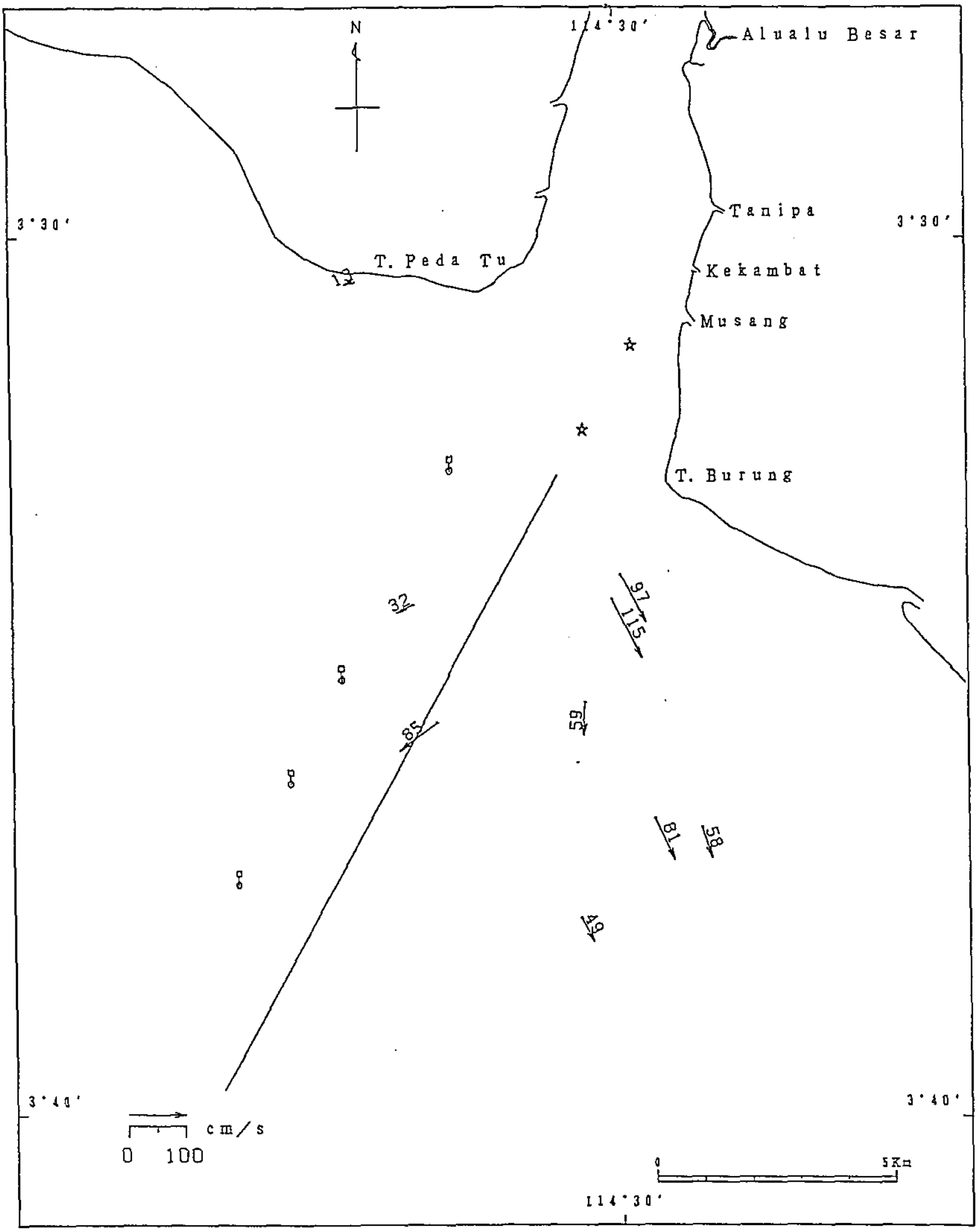


Fig. 5.3.3 − 2 (5) Current Obtained by Buoy Tracking Survey (12 hours after H.W)
(1st General Survey)

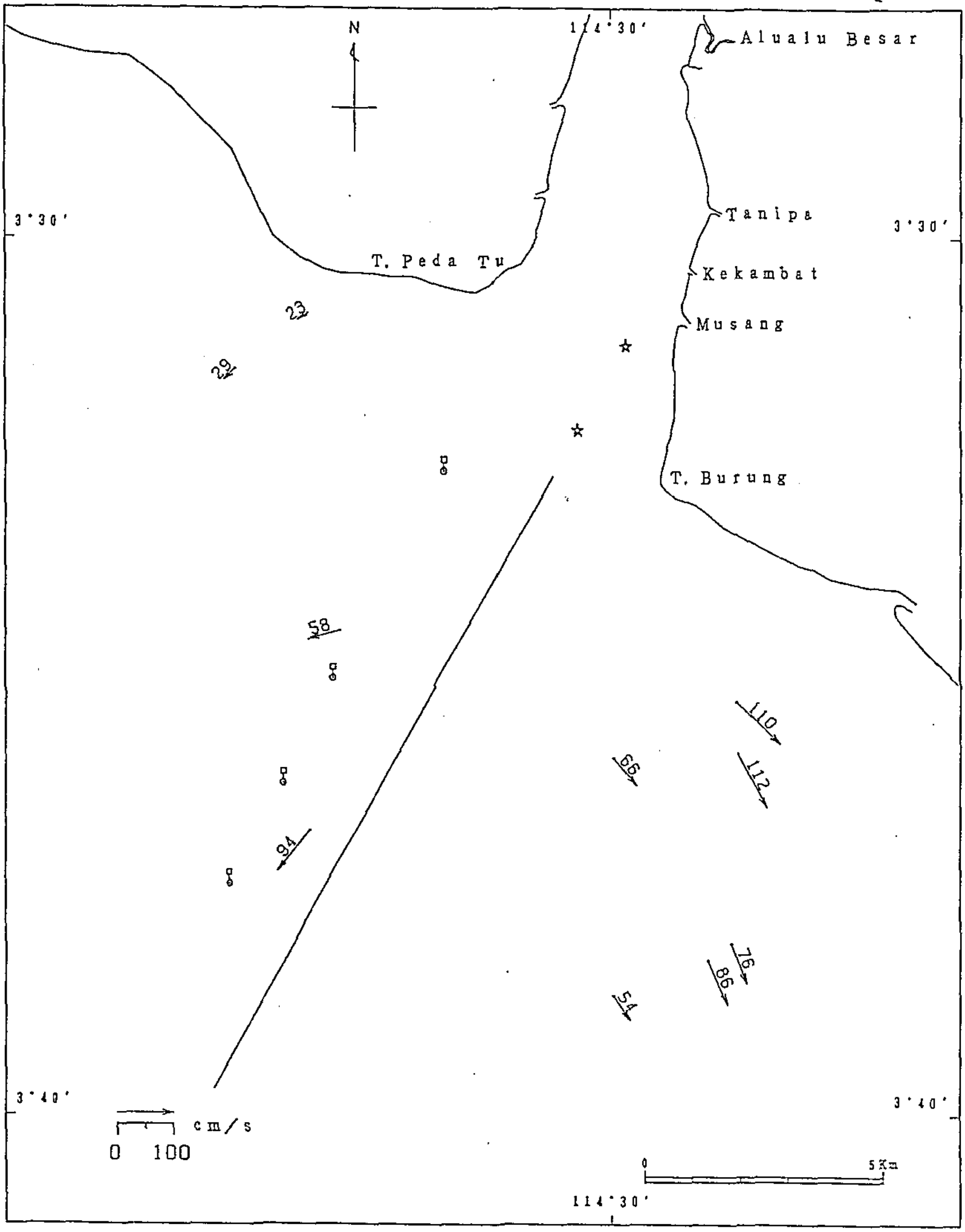


Fig. 5.3.3－2(6) Current Obtained by Buoy Tracking Survey (13 hours after H.W)
(1st General Survey)

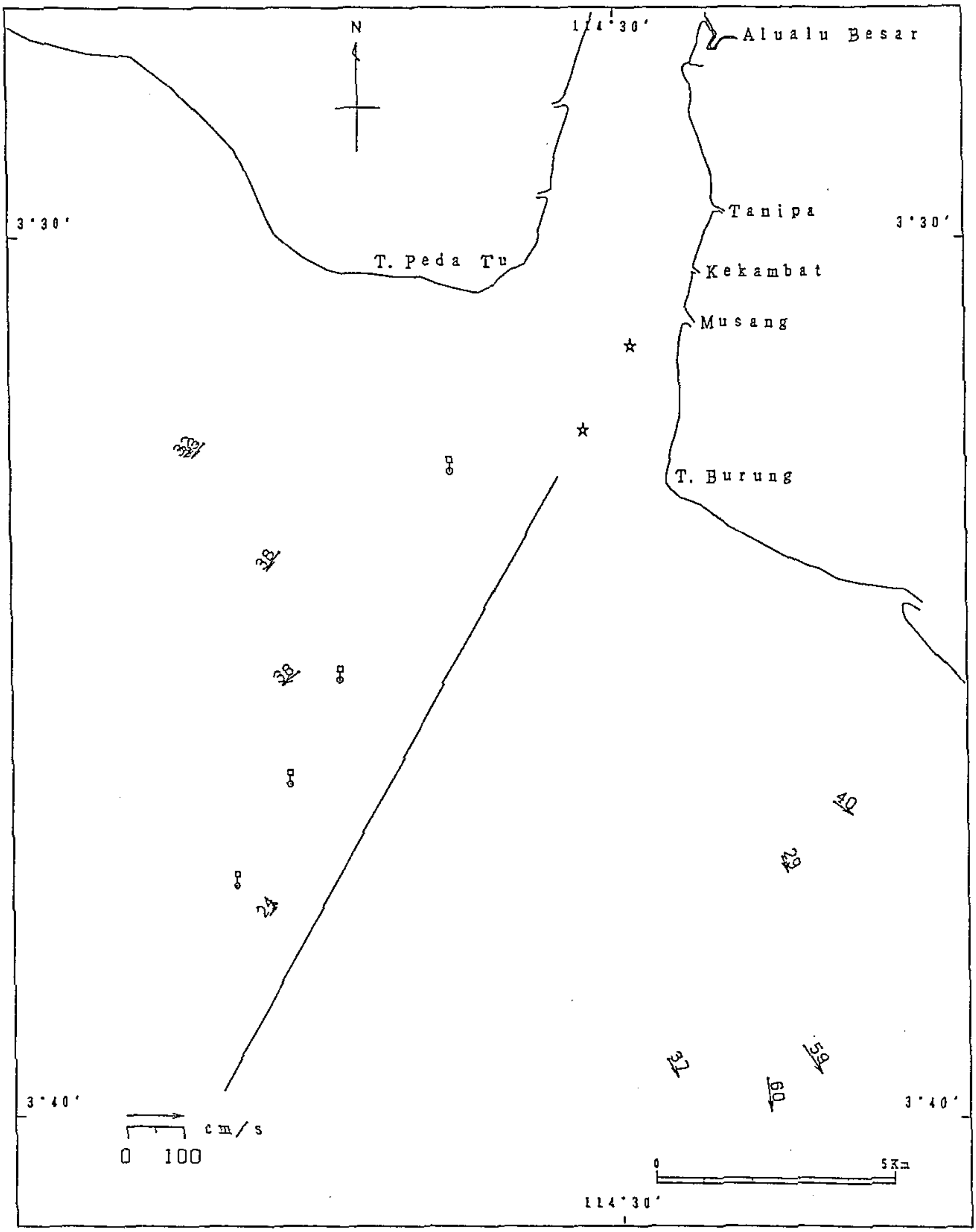


Fig. 5.3.3 − 2 (7) Current Obtained by Buoy Tracking Survey (14 hours after H.W)
(1st General Survey)

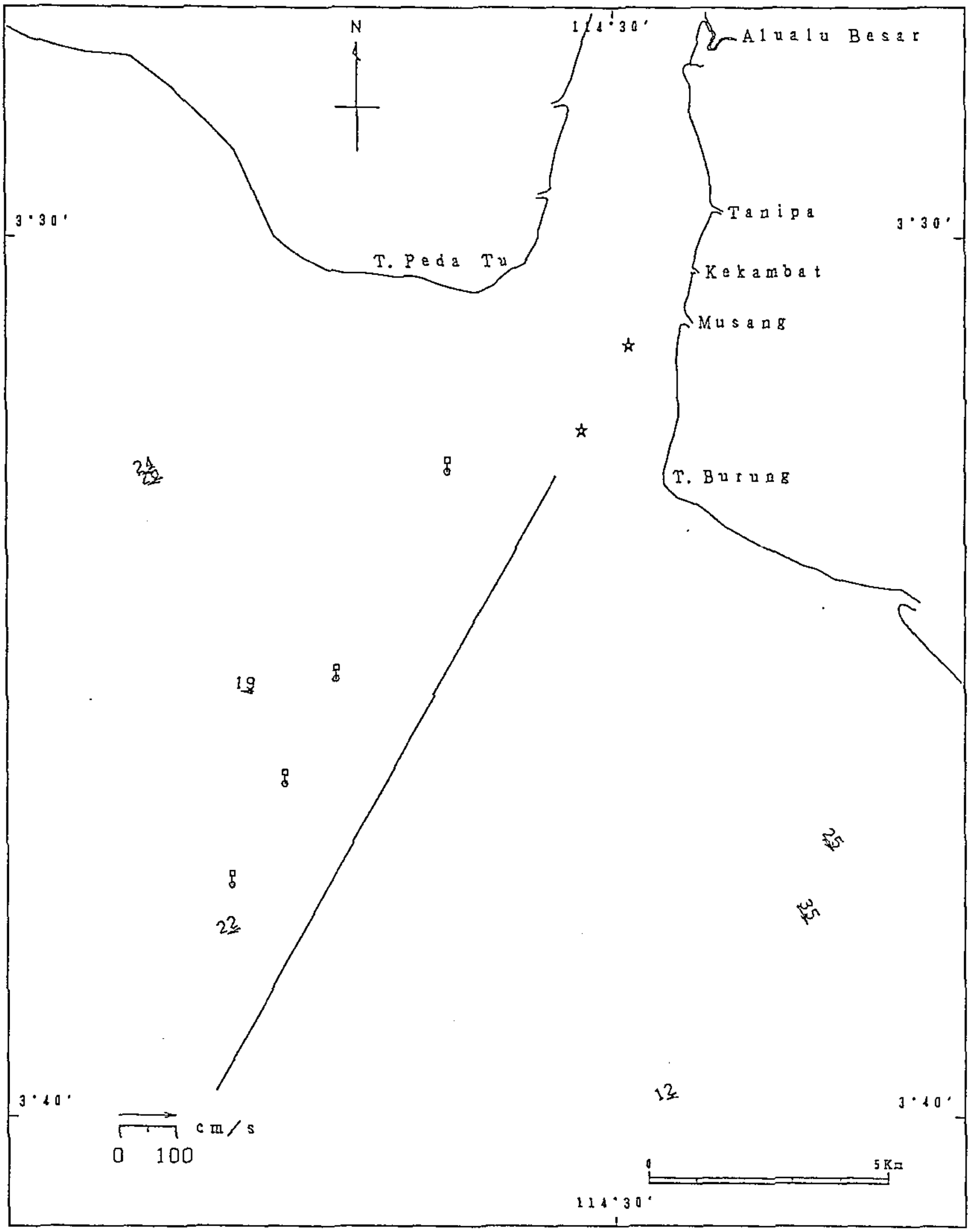


Fig. 5.3.3 − 2 (8) Current Obtained by Buoy Tracking Survey (15 hours after H.W)
(1st General Survey)

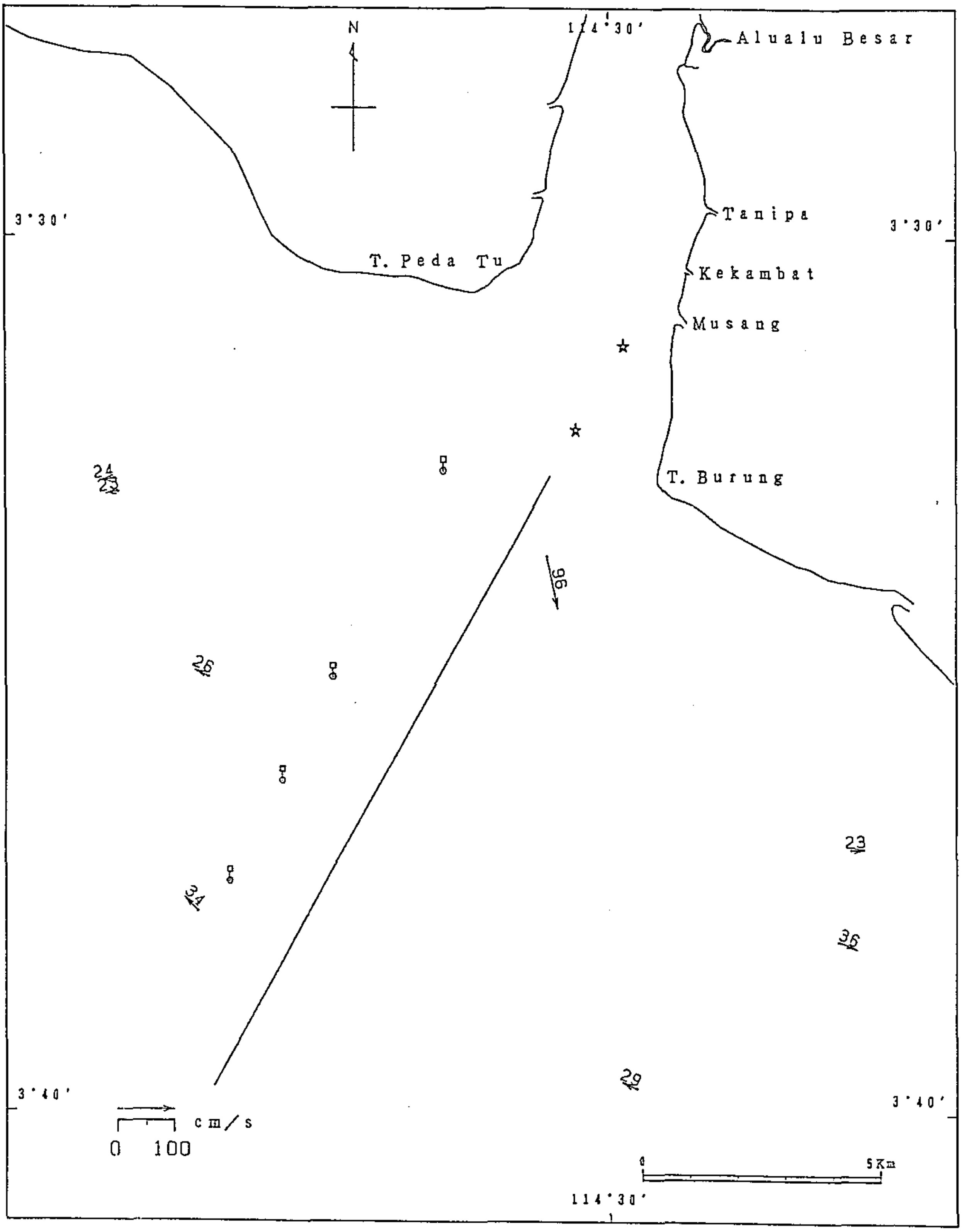


Fig. 5.3.3 − 2 (9) Current Obtained by Buoy Tracking Survey (16 hours after H.W)
(1st General Survey)

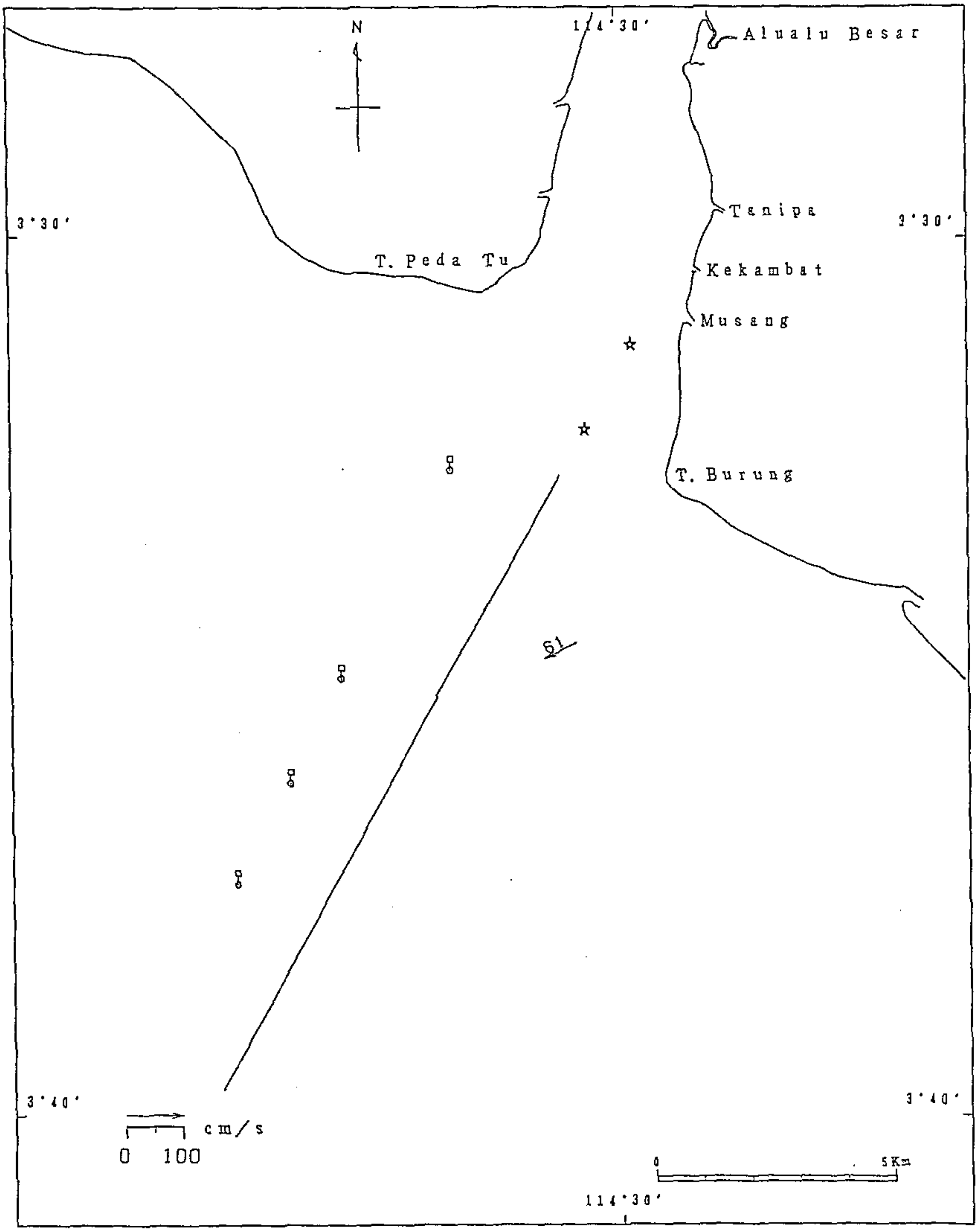


Fig. 5.3.3－2(10) Current Obtained by Buoy Tracking Survey (17 hours after H.W)
(1st General Survey)

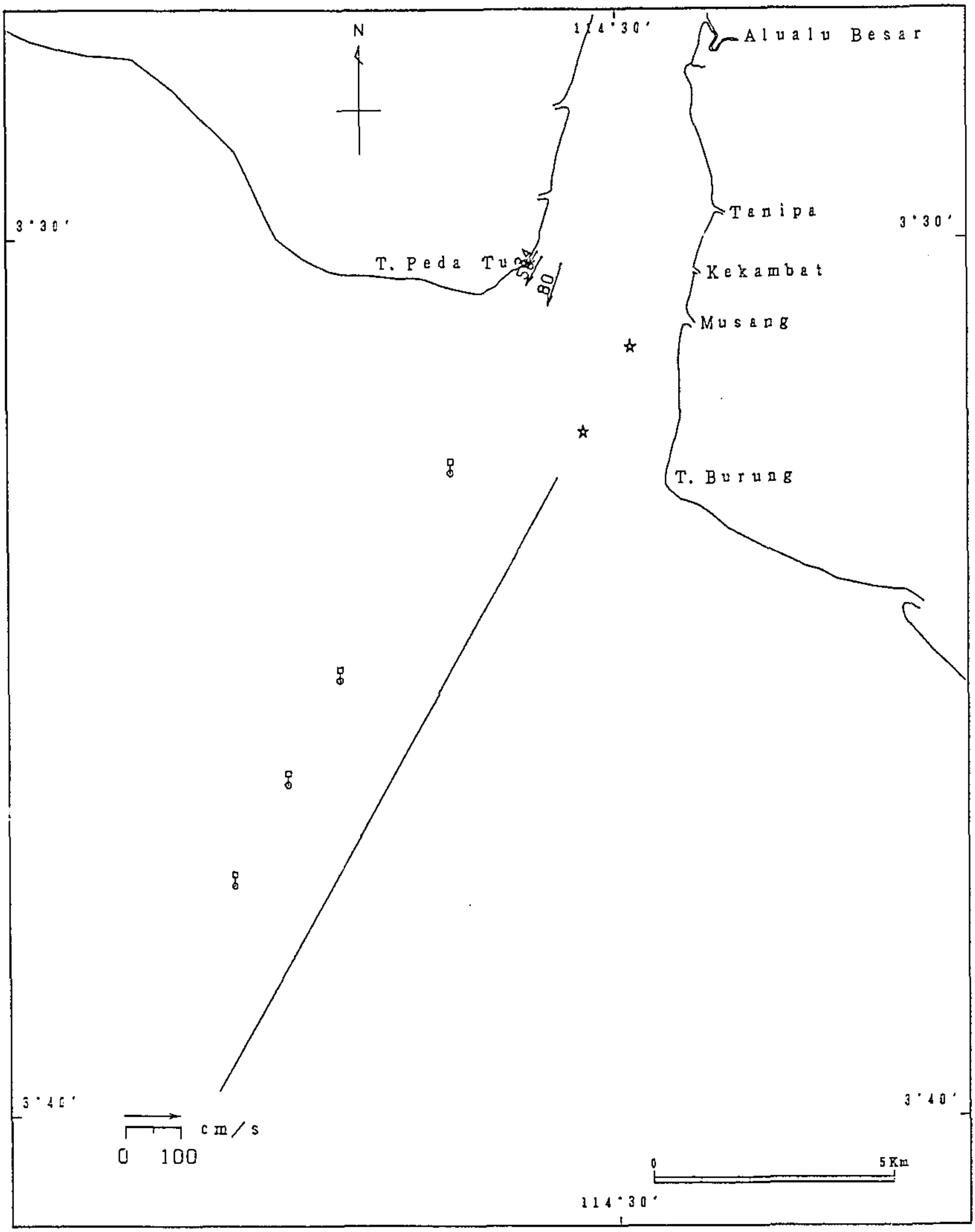


Fig. 5.3.3 − 2 (11) Current Obtained by Buoy Tracking Survey (10 hours before H.W)
(2nd General Survey)

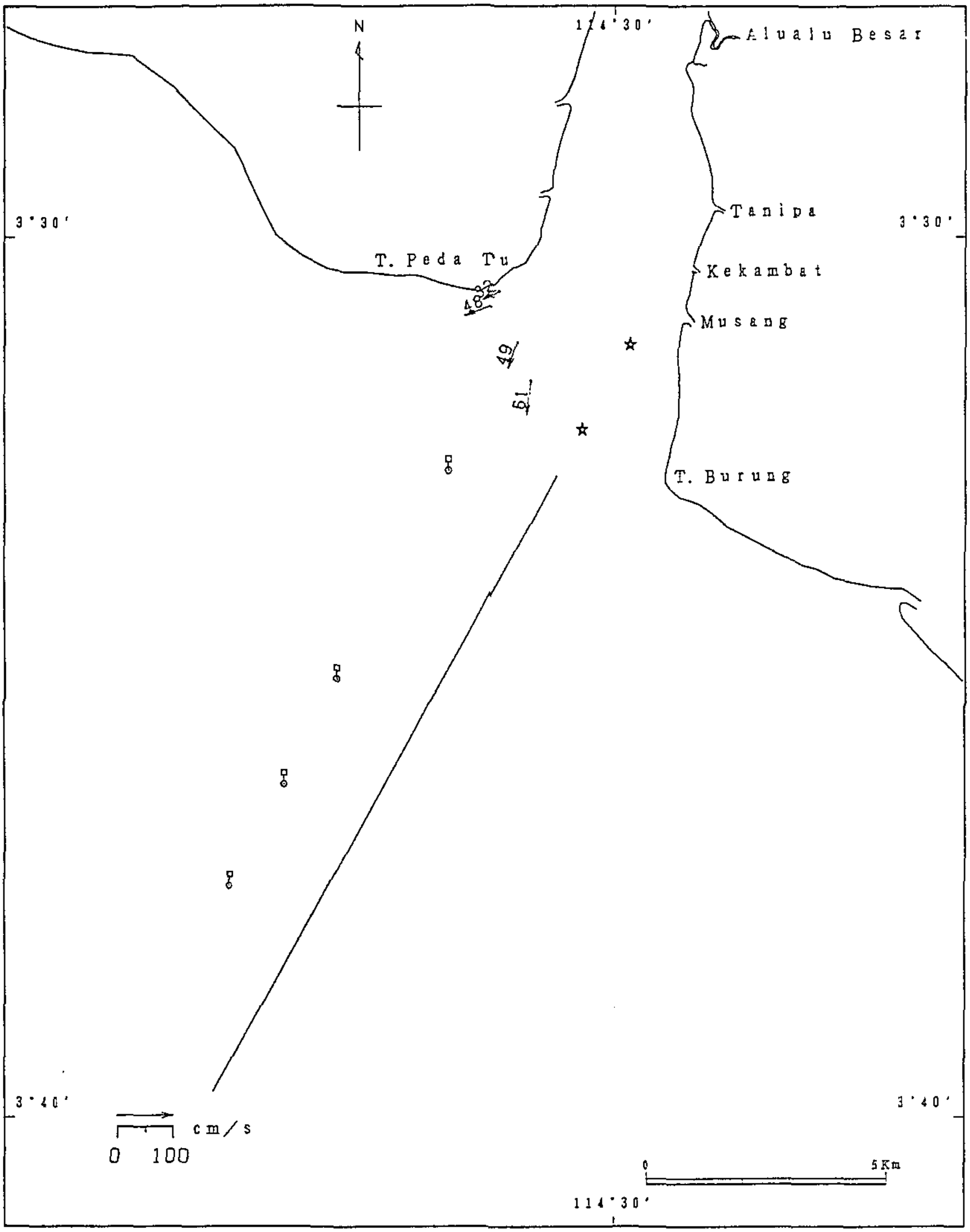


Fig. 5.3.3－2 (12) Current Obtained by Buoy Tracking Survey (9 hours before H.W)
(2nd General Survey)

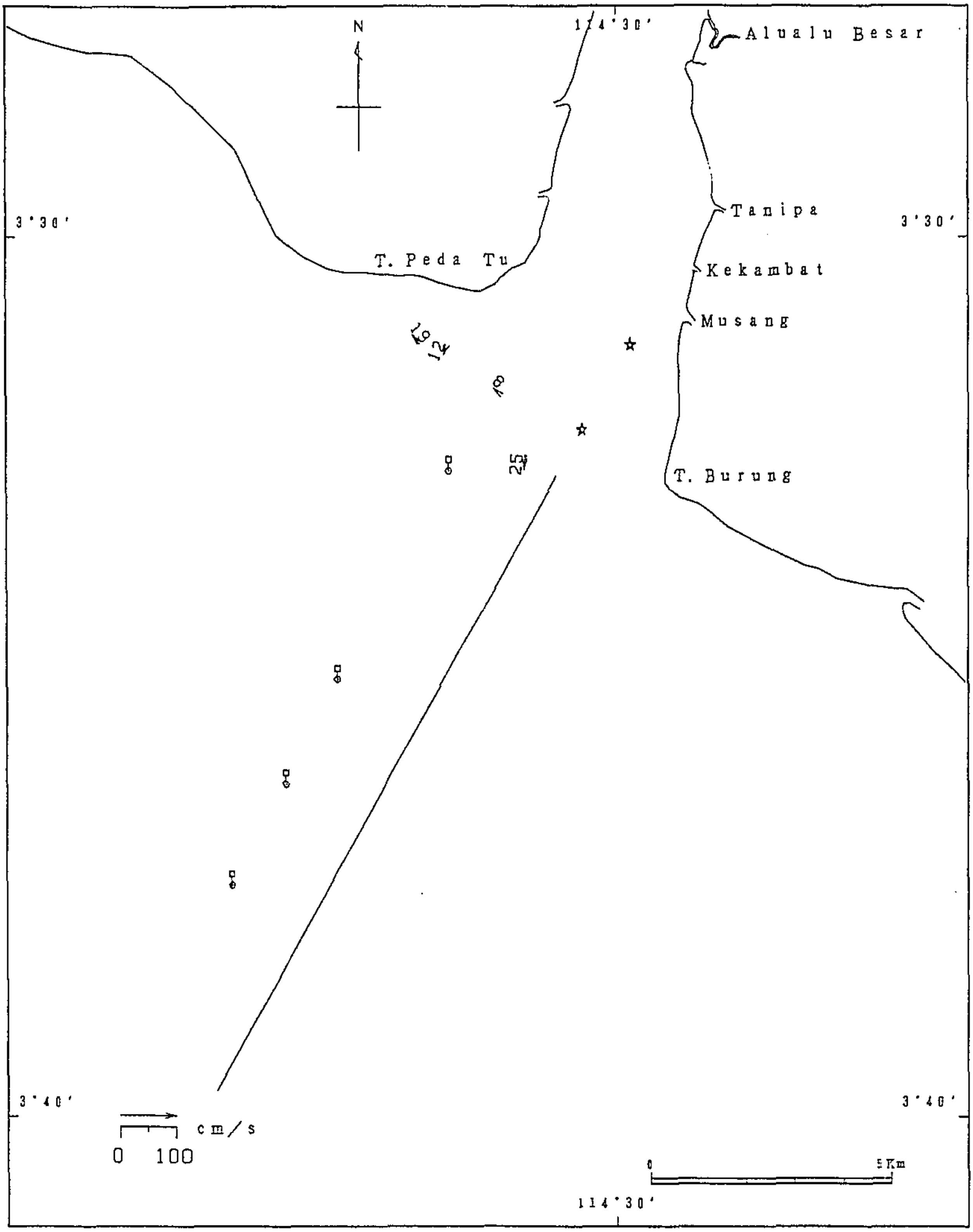


Fig. 5.3.3－2(13) Current Obtained by Buoy Tracking Survey (8 hours beforeH.W)
(2nd General Survey)

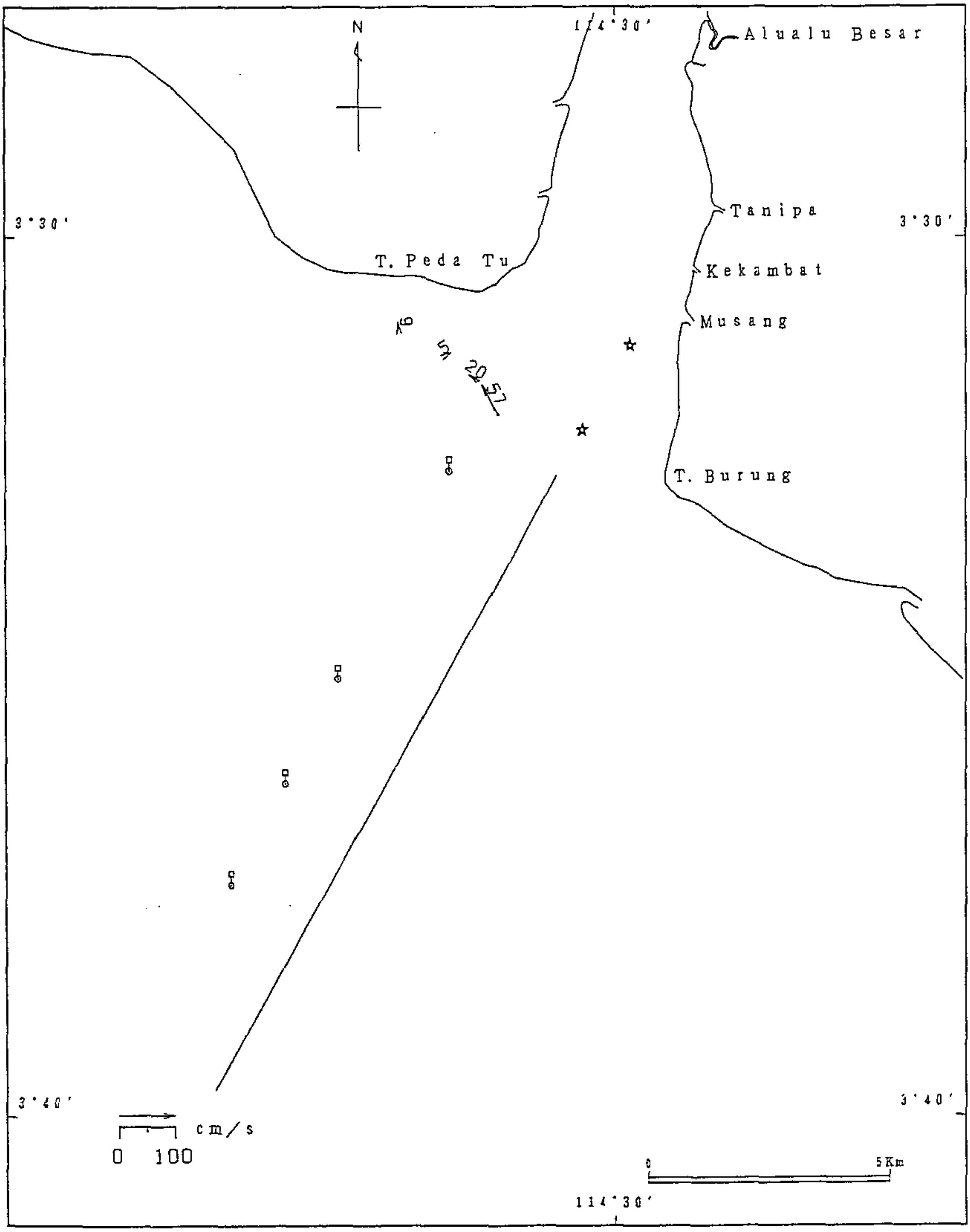


Fig. 5.3.3－2 (14) Current Obtained by Buoy Tracking Survey (7 hours before H.W)
(2nd General Survey)

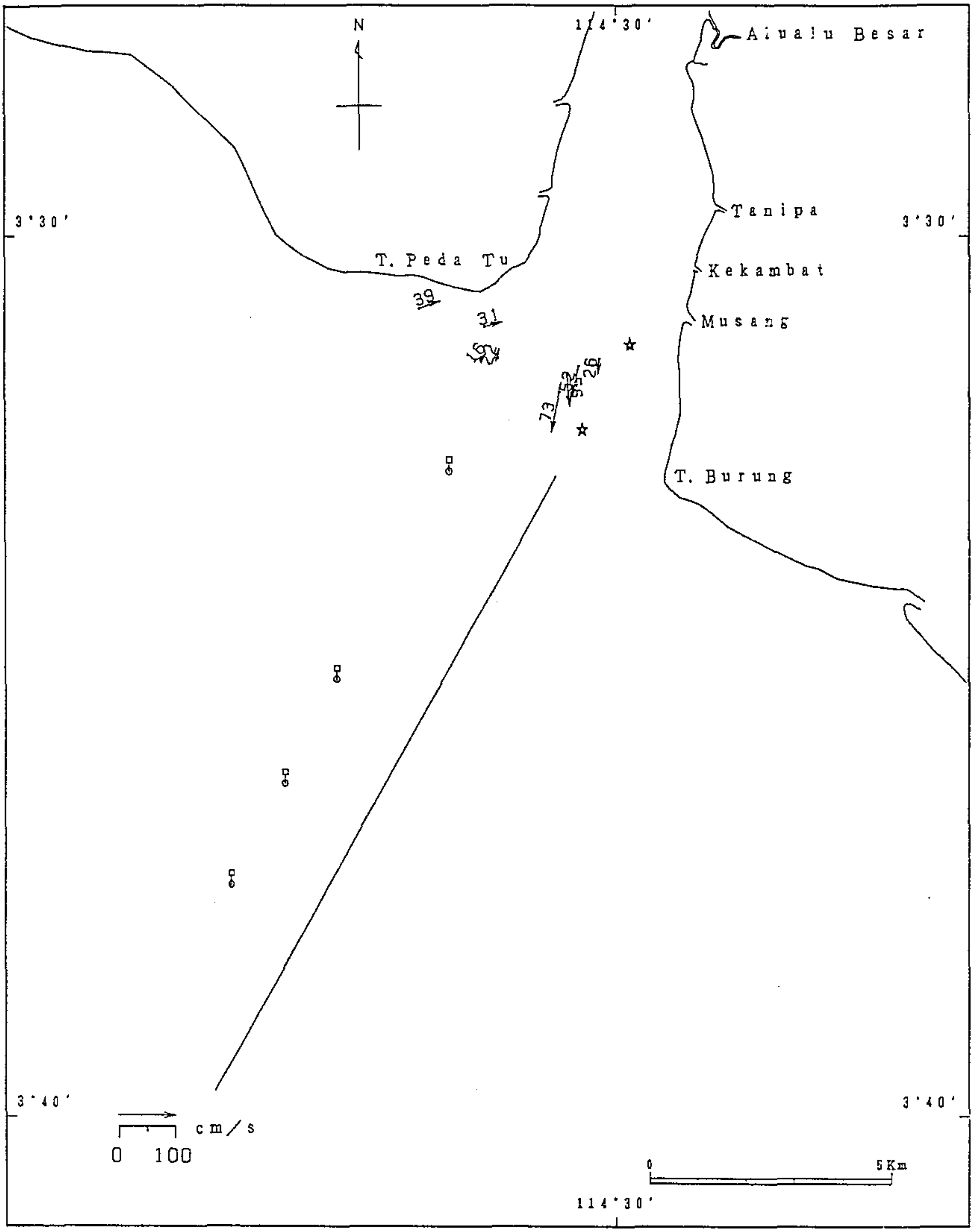


Fig. 5.3.3-2(15) Current Obtained by Buoy Tracking Survey (6 hours before H.W)
(2nd General Survey)

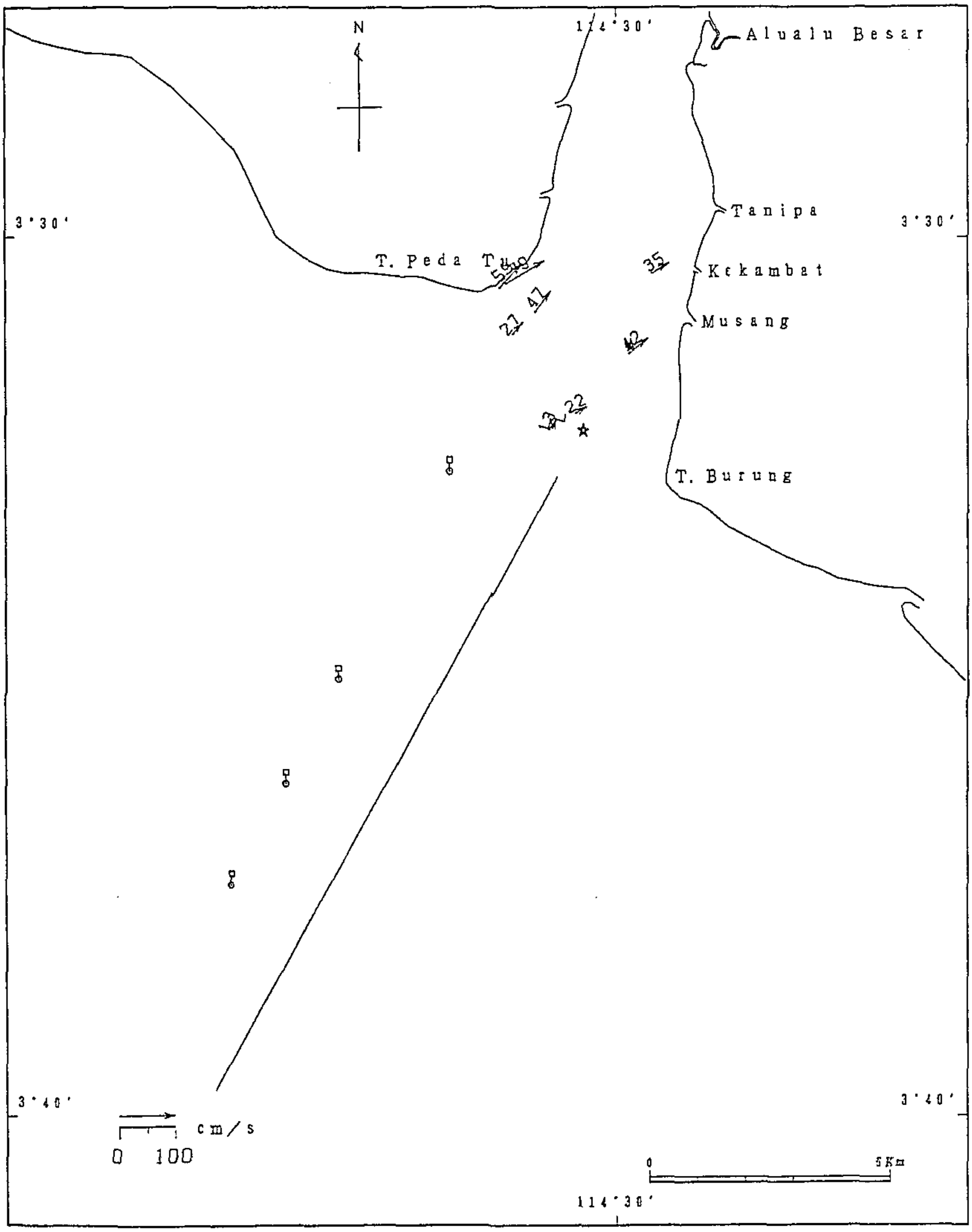


Fig. 5.3.3－2(16) Current Obtained by Buoy Tracking Survey (5 hours before H.W)
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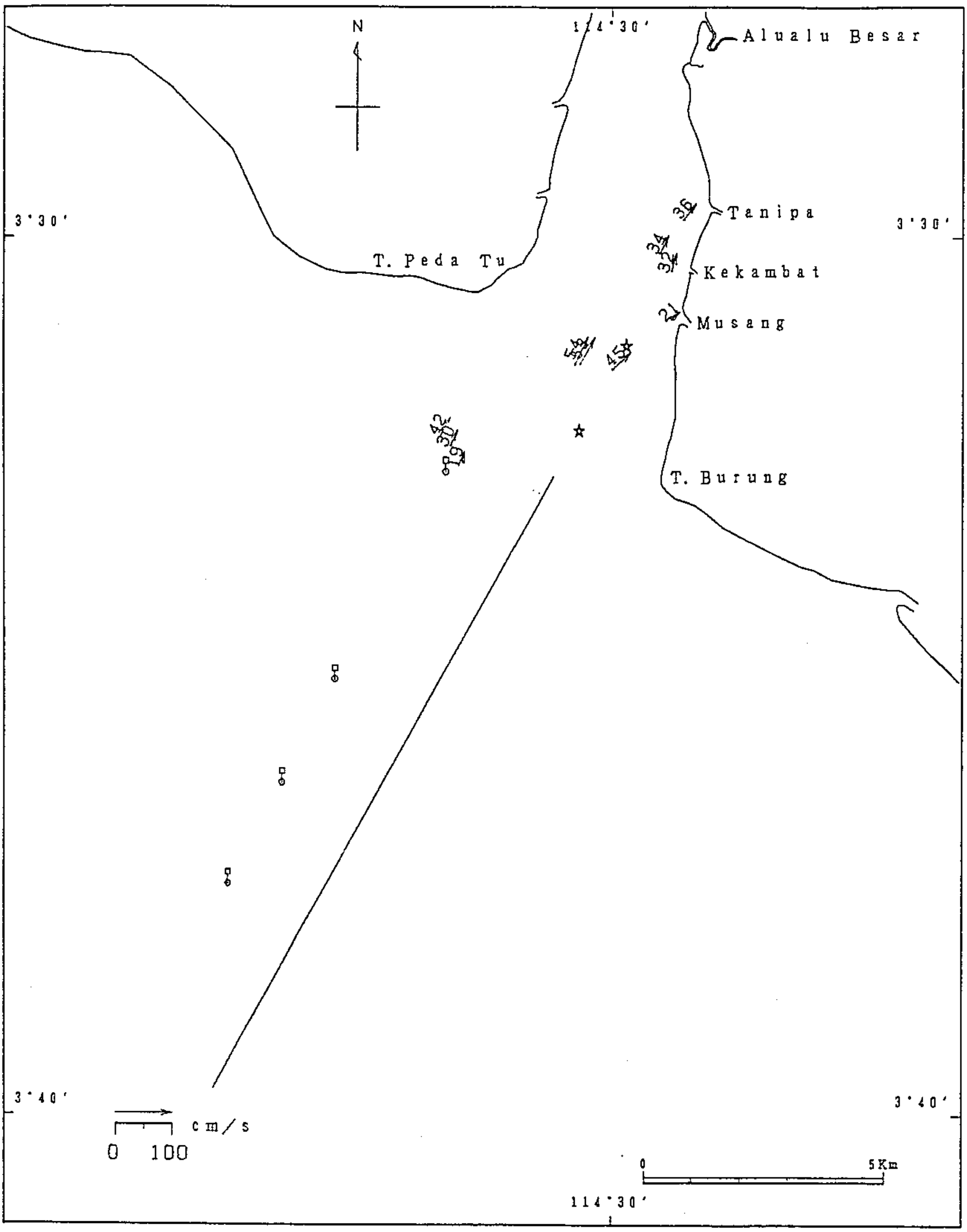

Fig. 5.3.3－2(17) Current Obtained by Buoy Tracking Survey (4 hours before H.W)
(2nd General Survey)

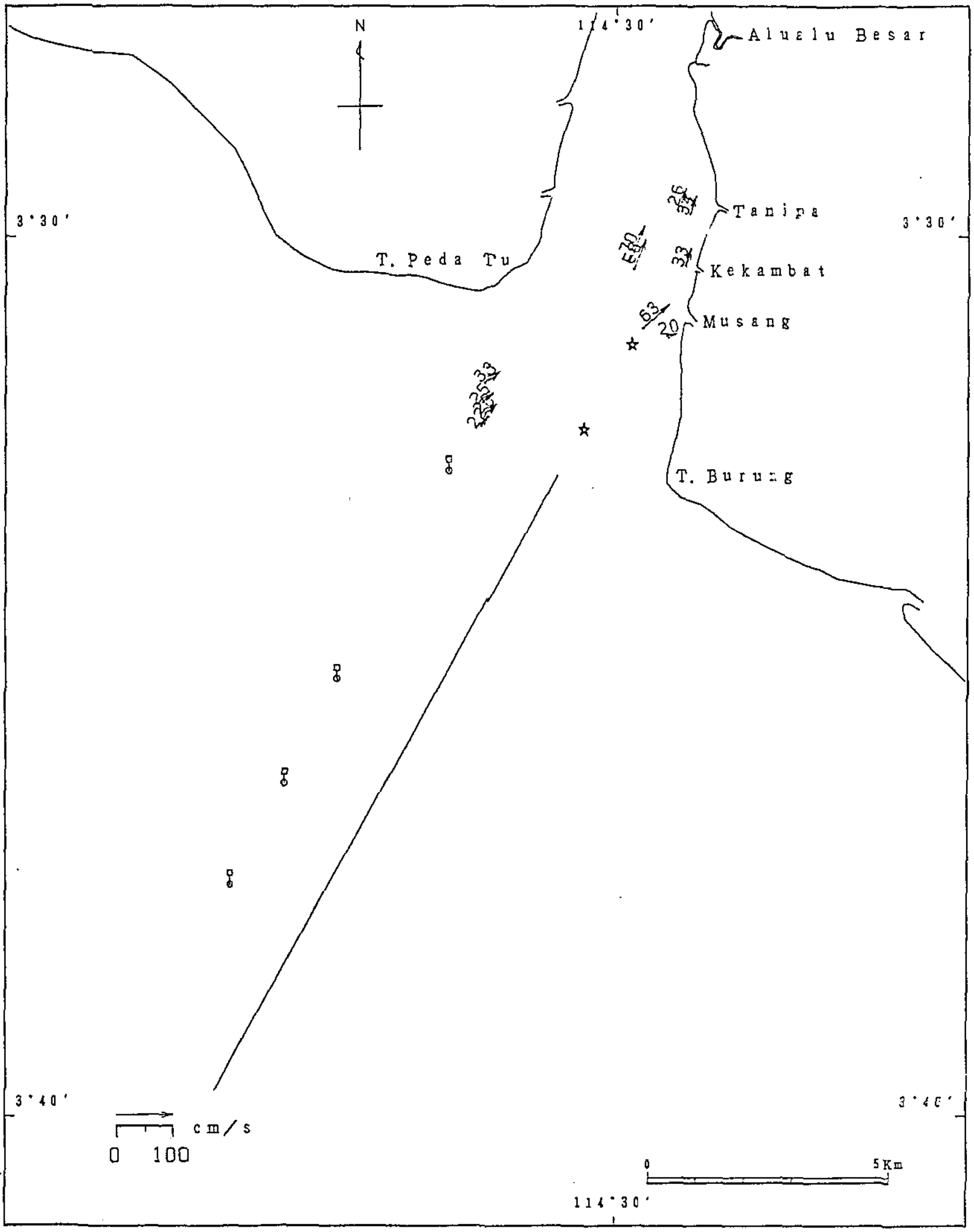

Fig. 5.3.3 − 2 (18) Current Obtained by Buoy Tracking Survey (3 hours before H.W)
(2nd General Survey)

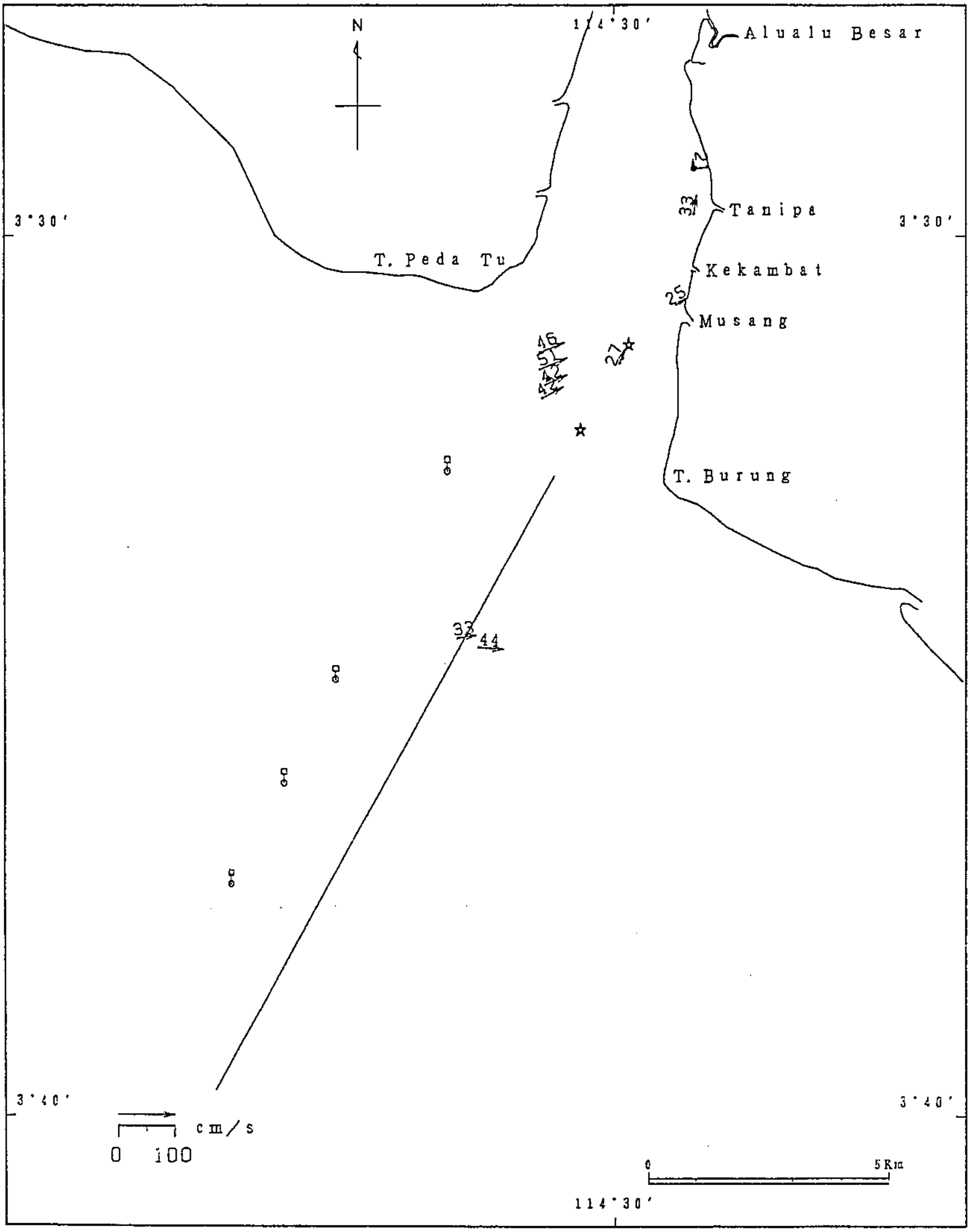

Fig. 5.3.3－2(19) Current Obtained by Buoy Tracking Survey (2 hours beforeH.W)
(2nd General Survey)

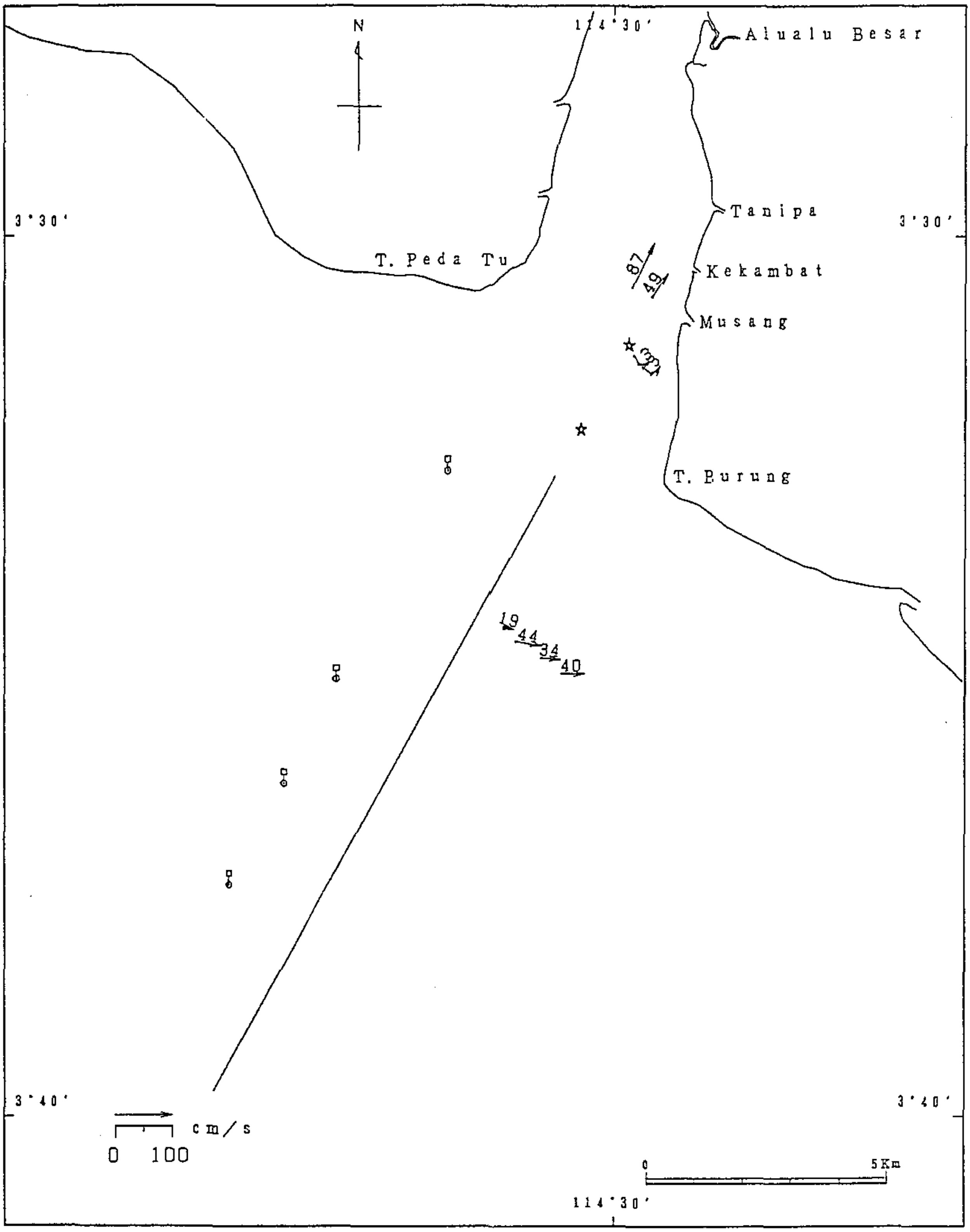

Fig. 5.3.3−2(20) Current Obtained by Buoy Tracking Survey (1 hours beforeH.W)
(2nd General Survey)

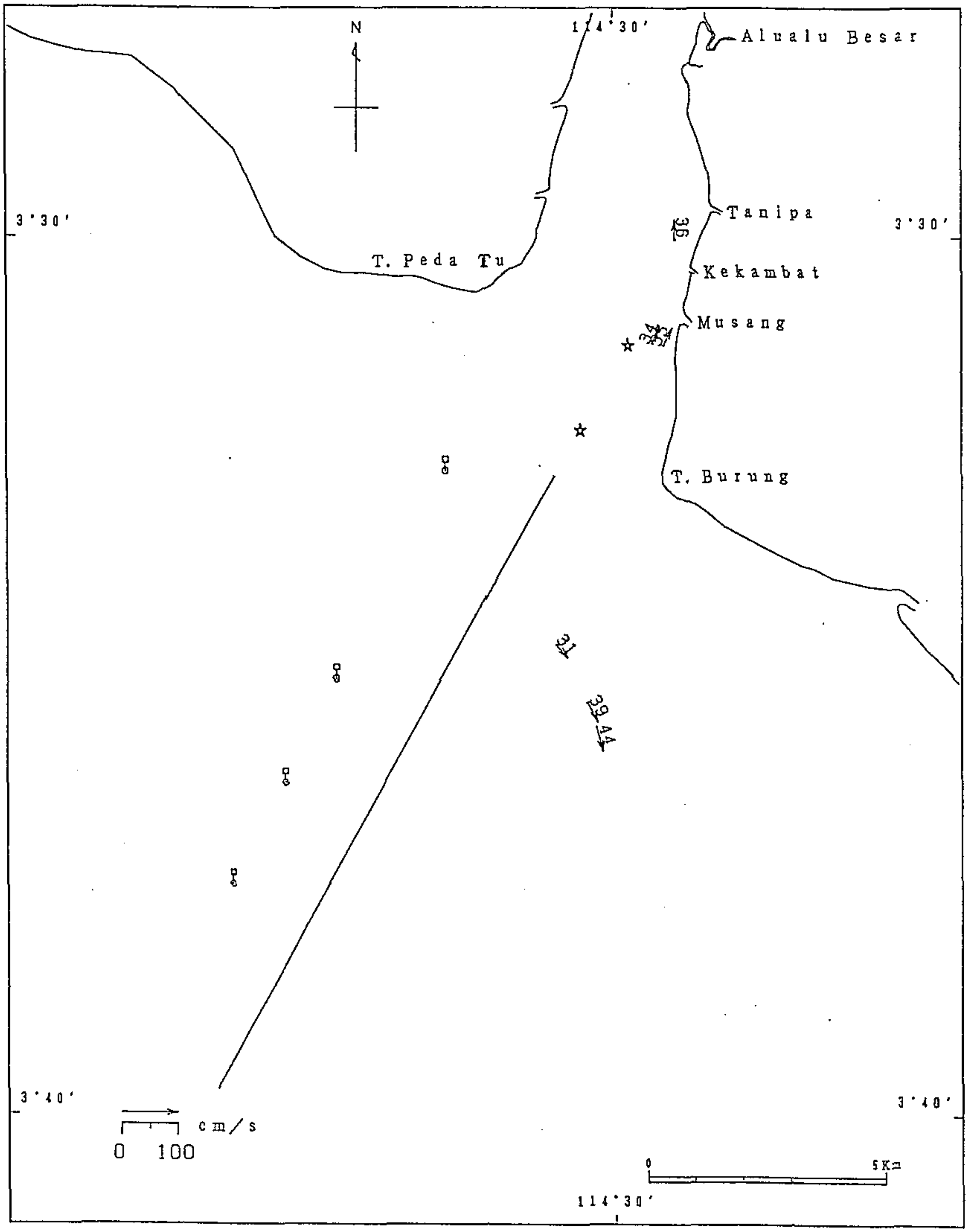

Fig. 5.3.3 − 2 (21) Current Obtained by Buoy Tracking Survey (H.W)
(2nd General Survey)

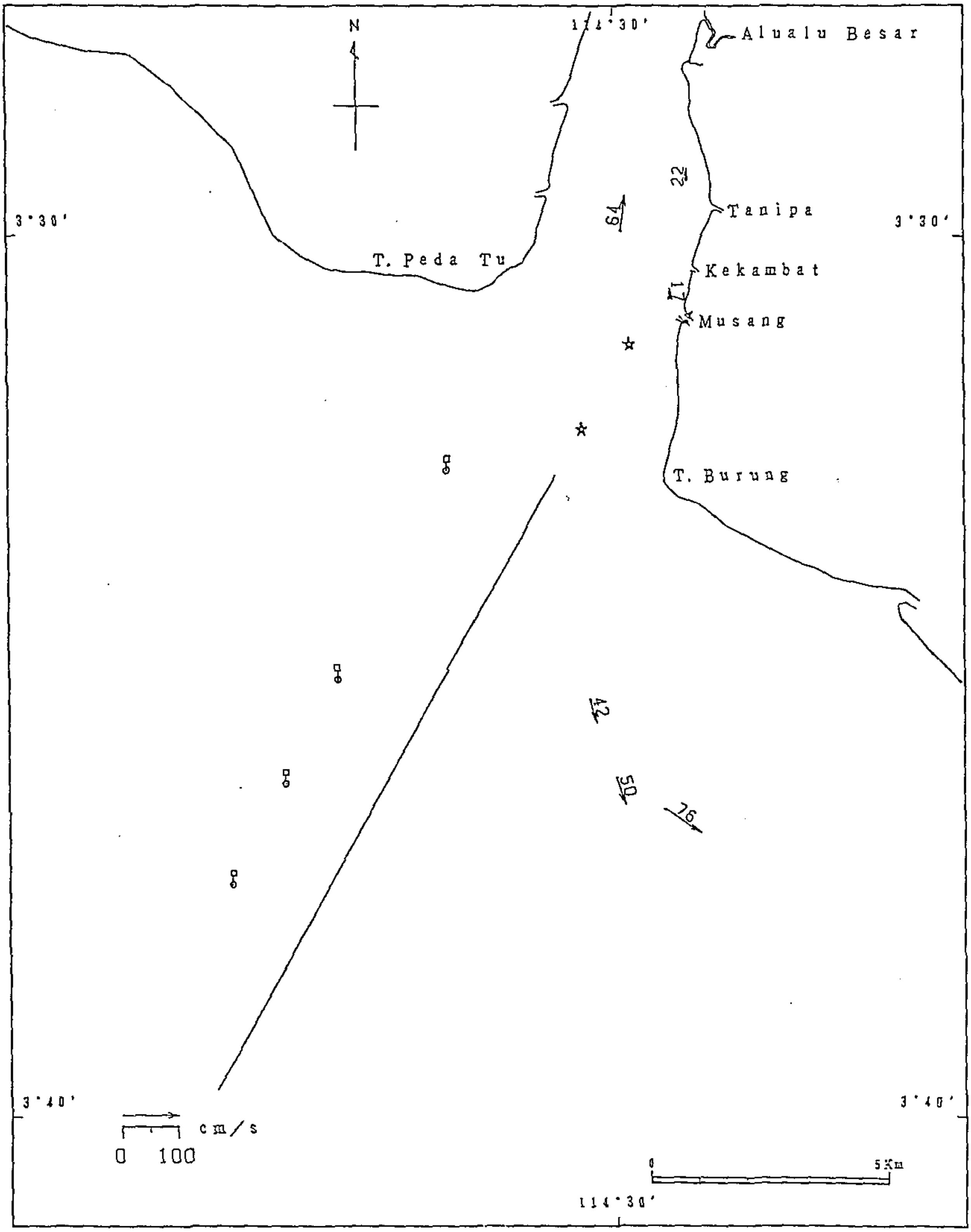

Fig. 5.3.3－2(22) Current Obtained by Buoy Tracking Survey (1 hours after H.W)
(2nd General Survey)

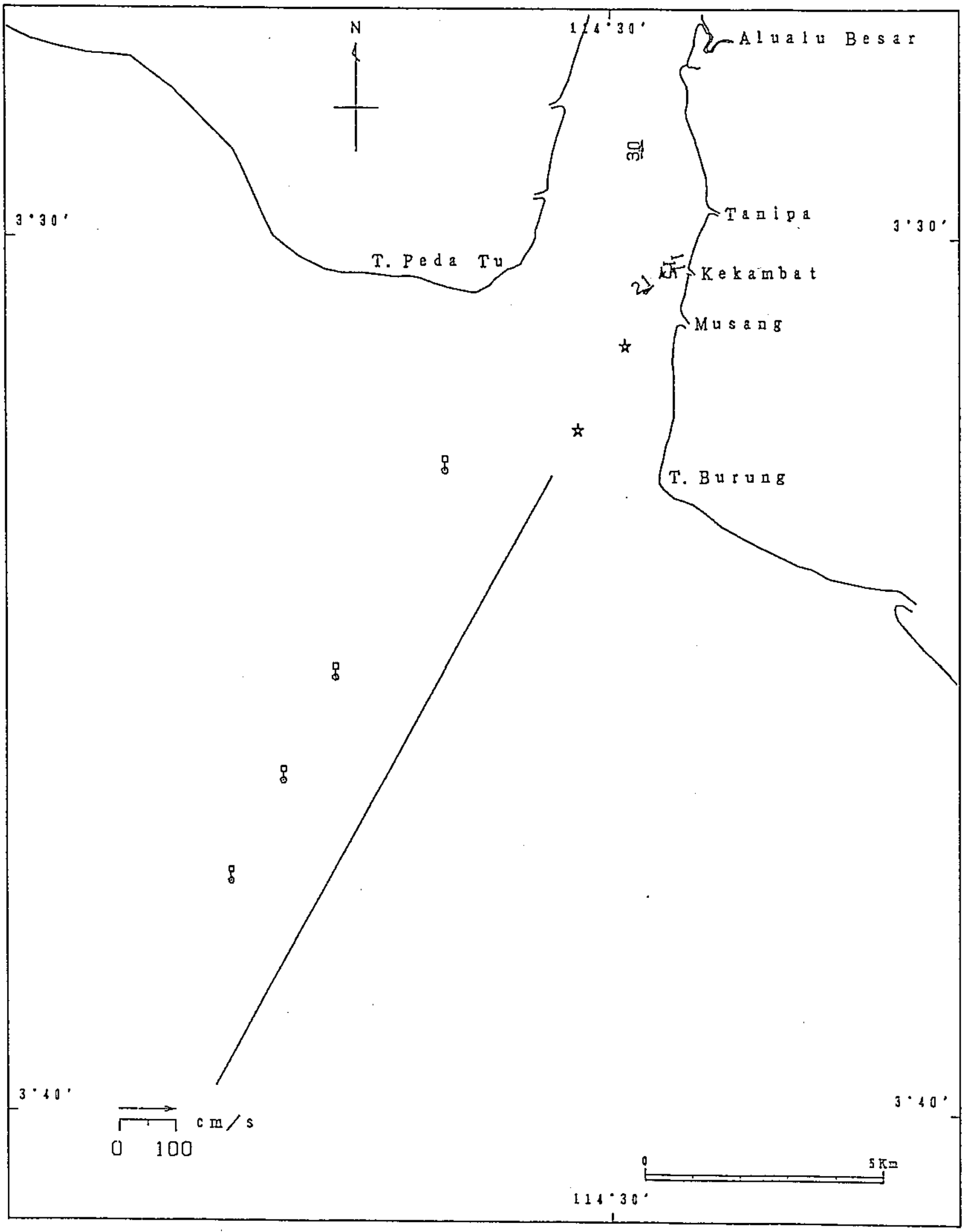

Fig. 5.3.3－2(23) Current Obtained by Buoy Tracking Survey (2 hours after H.W)
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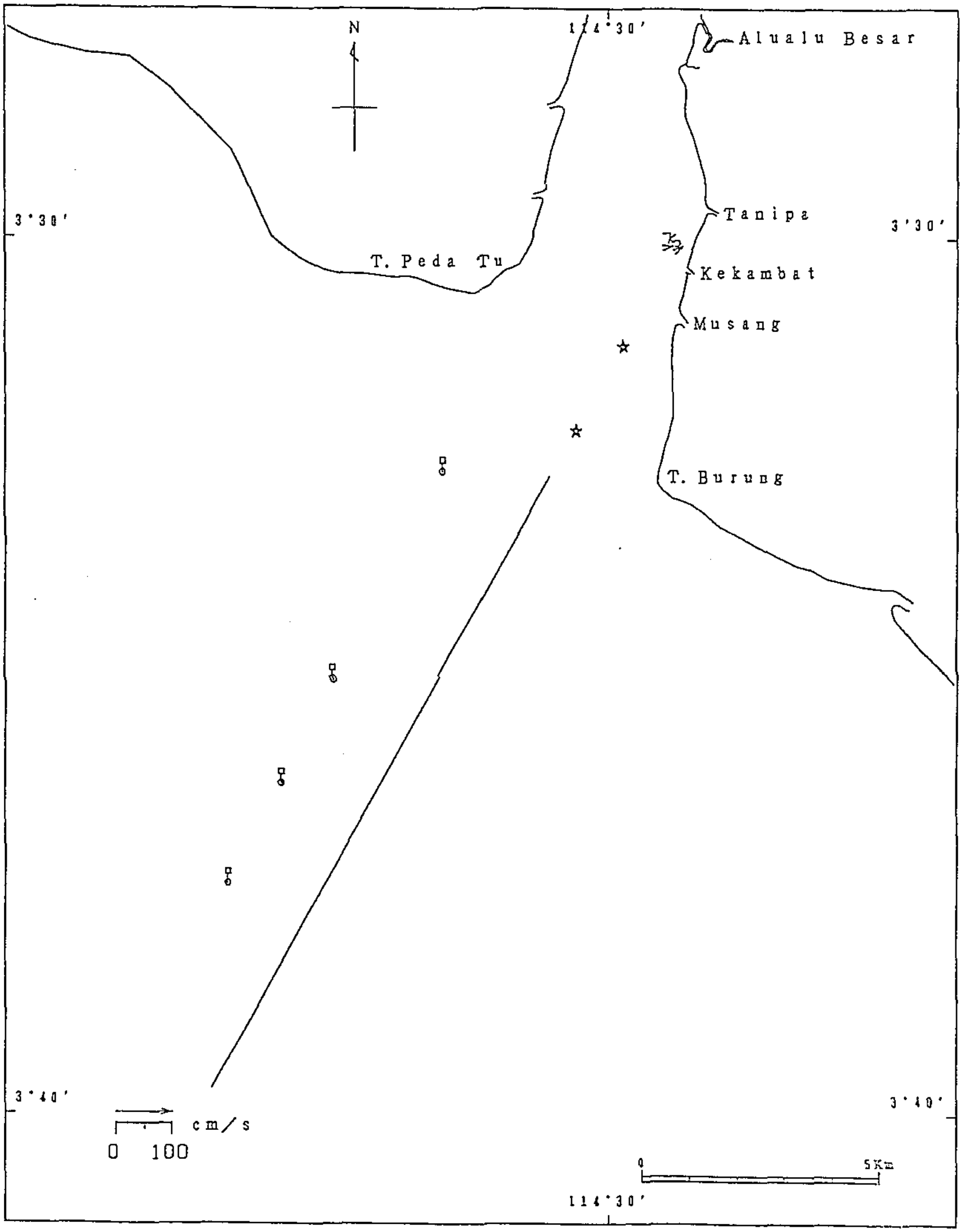


Fig. 5.3.3－2 (24) Current Obtained by Buoy Tracking Survey (3 hours after H.W)
(2nd General Survey)

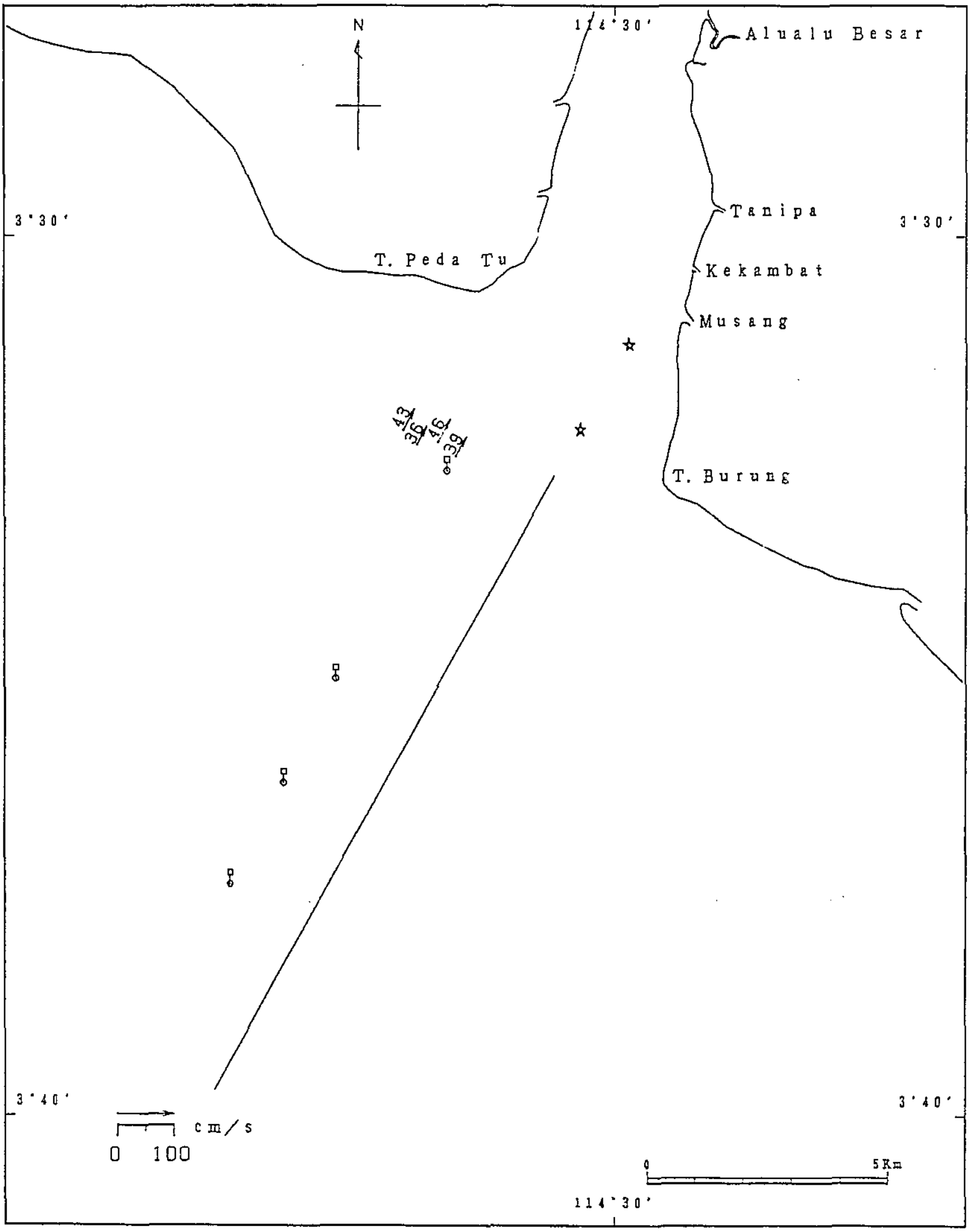


Fig. 5.3.3 − 2 (25) Current Obtained by Buoy Tracking Survey (4 hours beforeH.W)
(3rd General Survey)

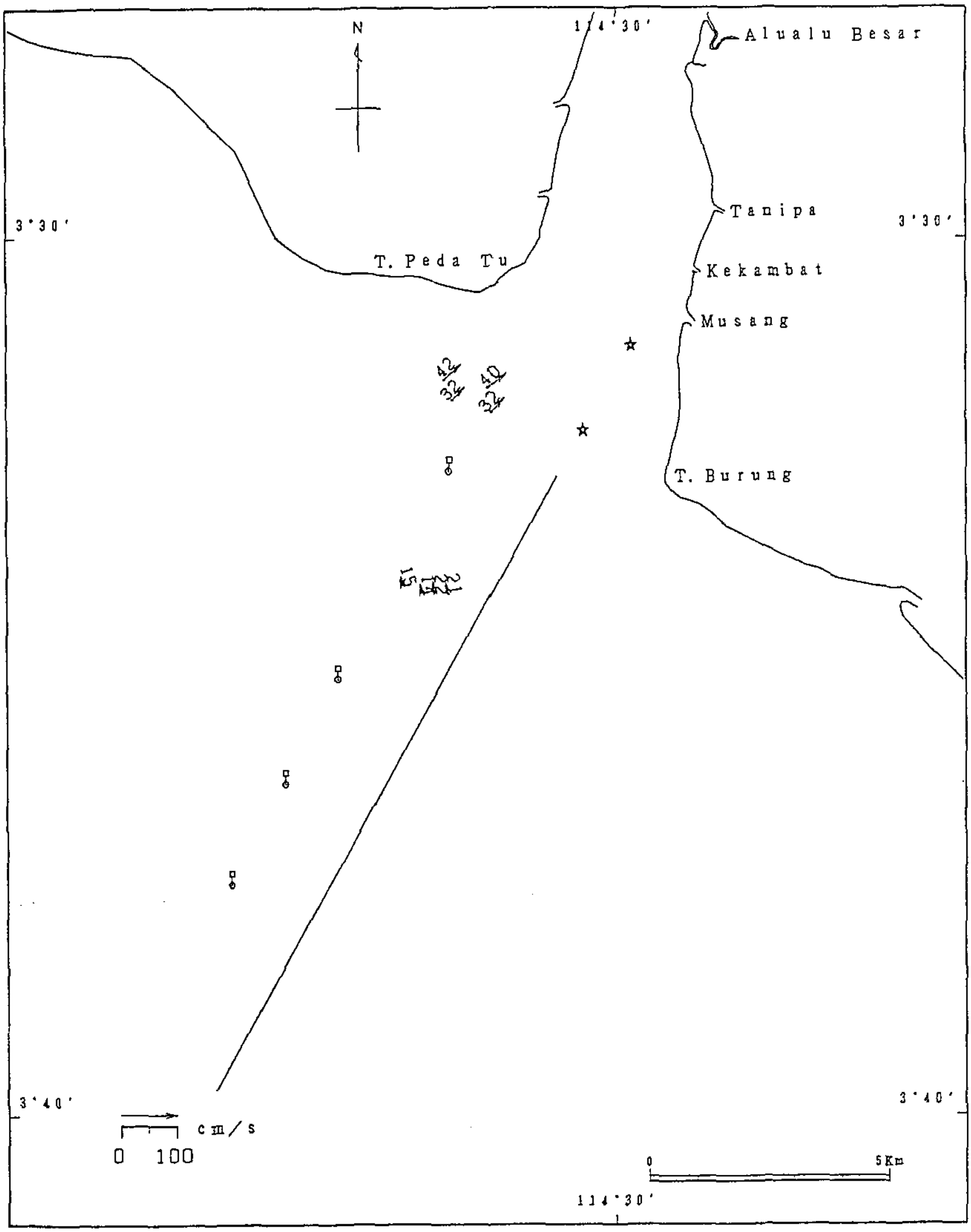


Fig. 5.3.3－2 (26) Current Obtained by Buoy Tracking Survey (3 hours before H.W)
(3rd General Survey)

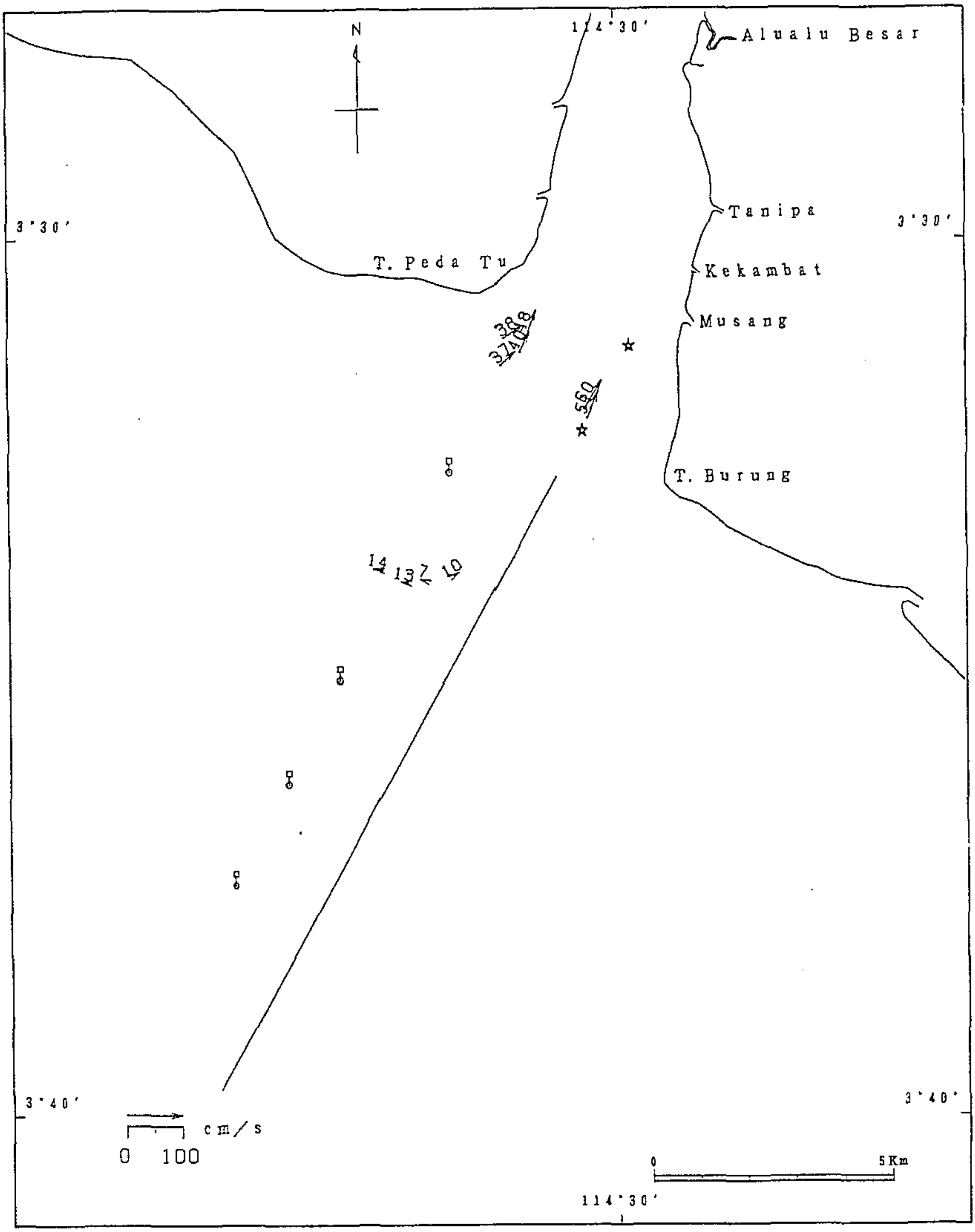


Fig. 5.3.3 − 2 (27) Current Obtained by Buoy Tracking Survey (2 hours before H.W)
(3rd General Survey)

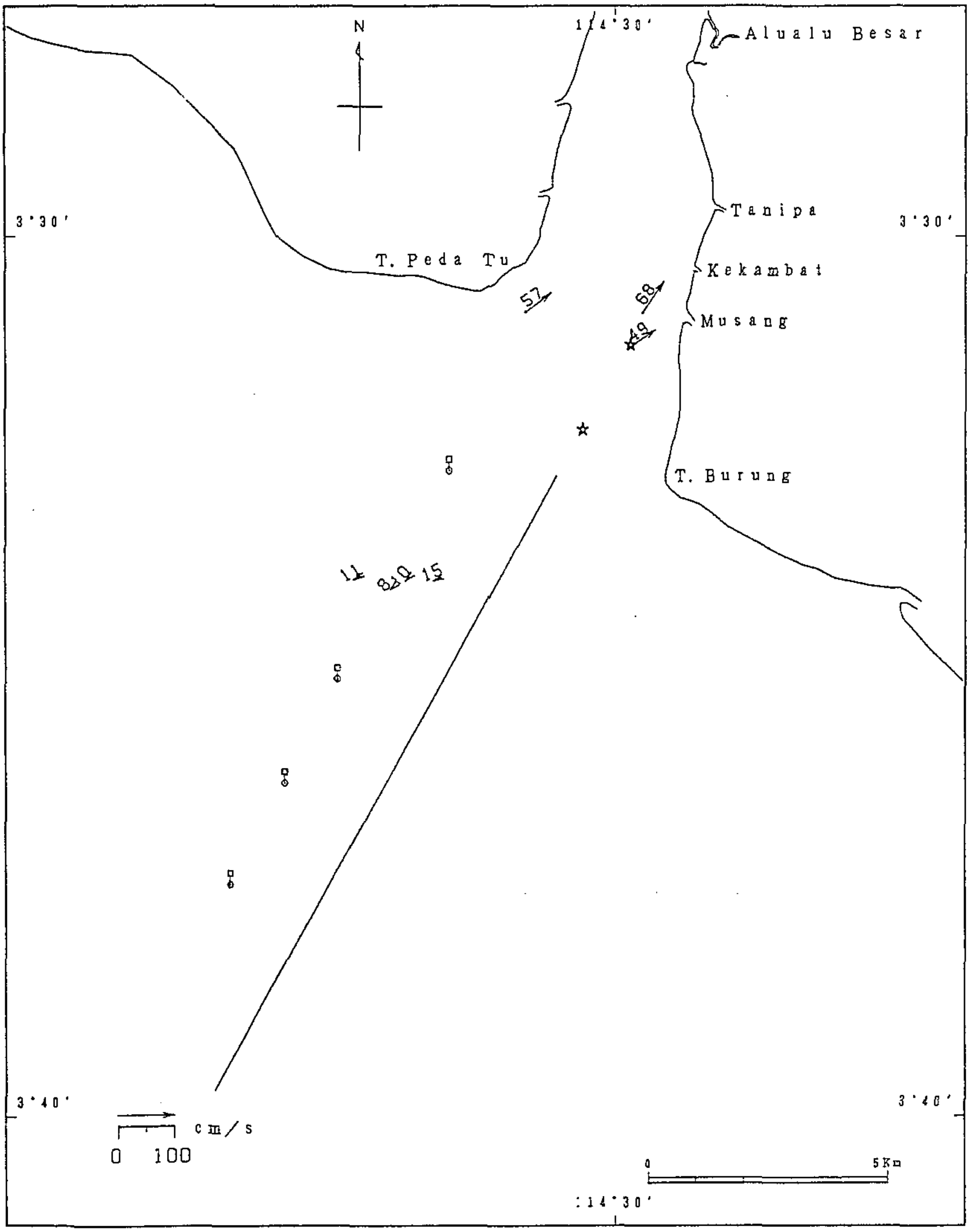


Fig. 5.3.3－2(28) Current Obtained by Buoy Tracking Survey (1 hours before H.W)
(3rd General Survey)

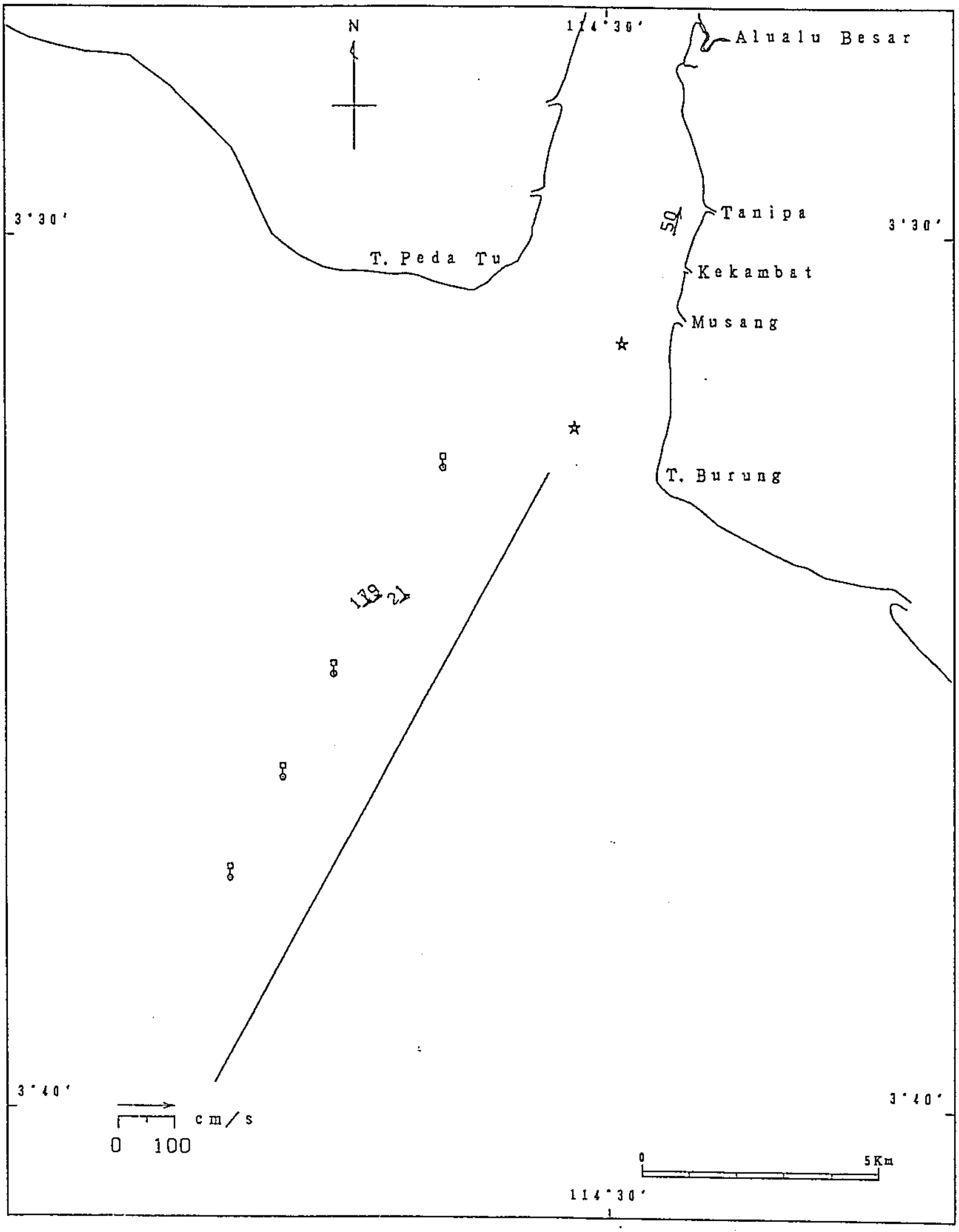


Fig. 5.3.3－2(29) Current Obtained by Buoy Tracking Survey (H.W)
(3rd General Survey)

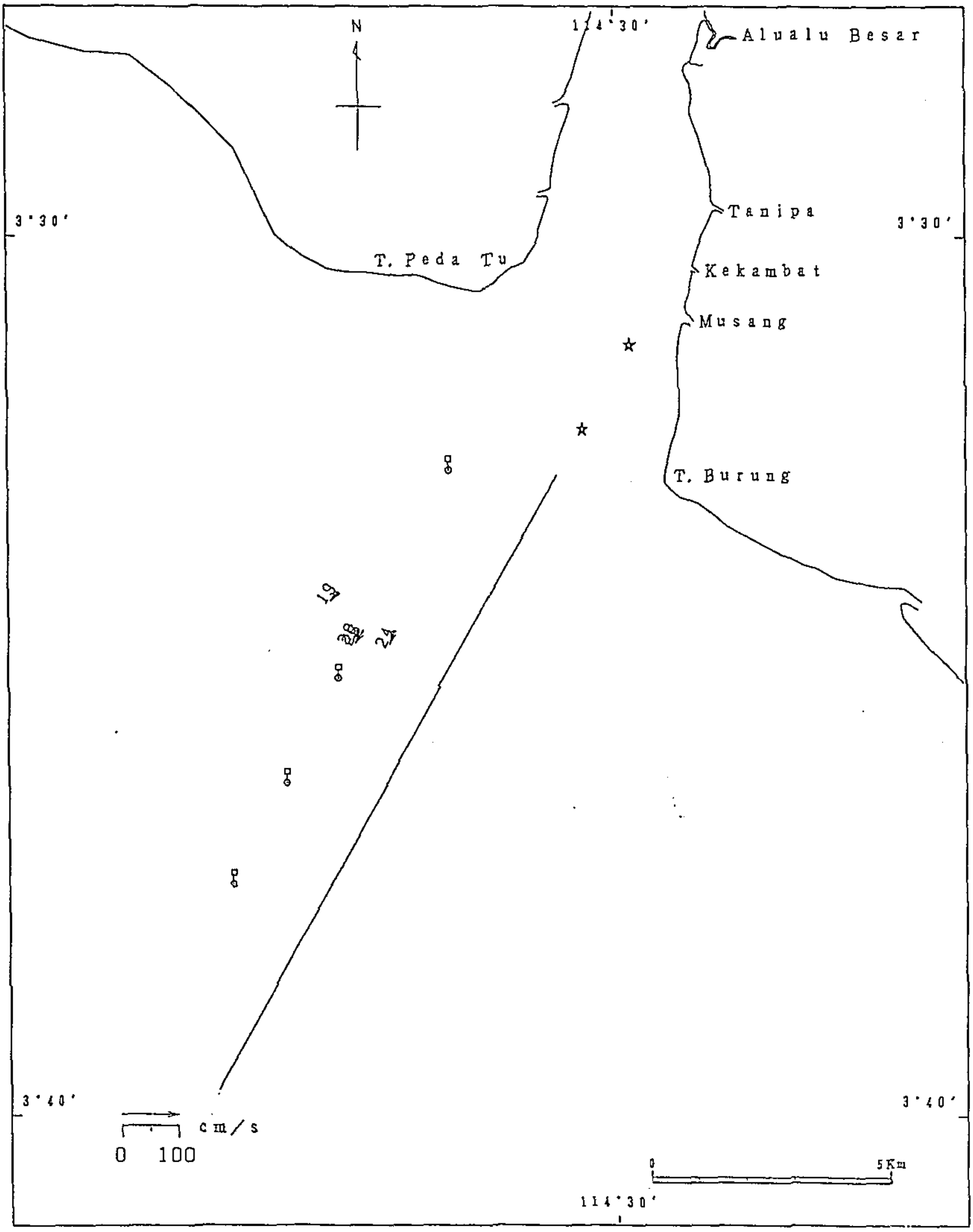


Fig. 5.3.3－2(30) Current Obtained by Buoy Tracking Survey (1 hours after H.W)
(3rd General Survey)

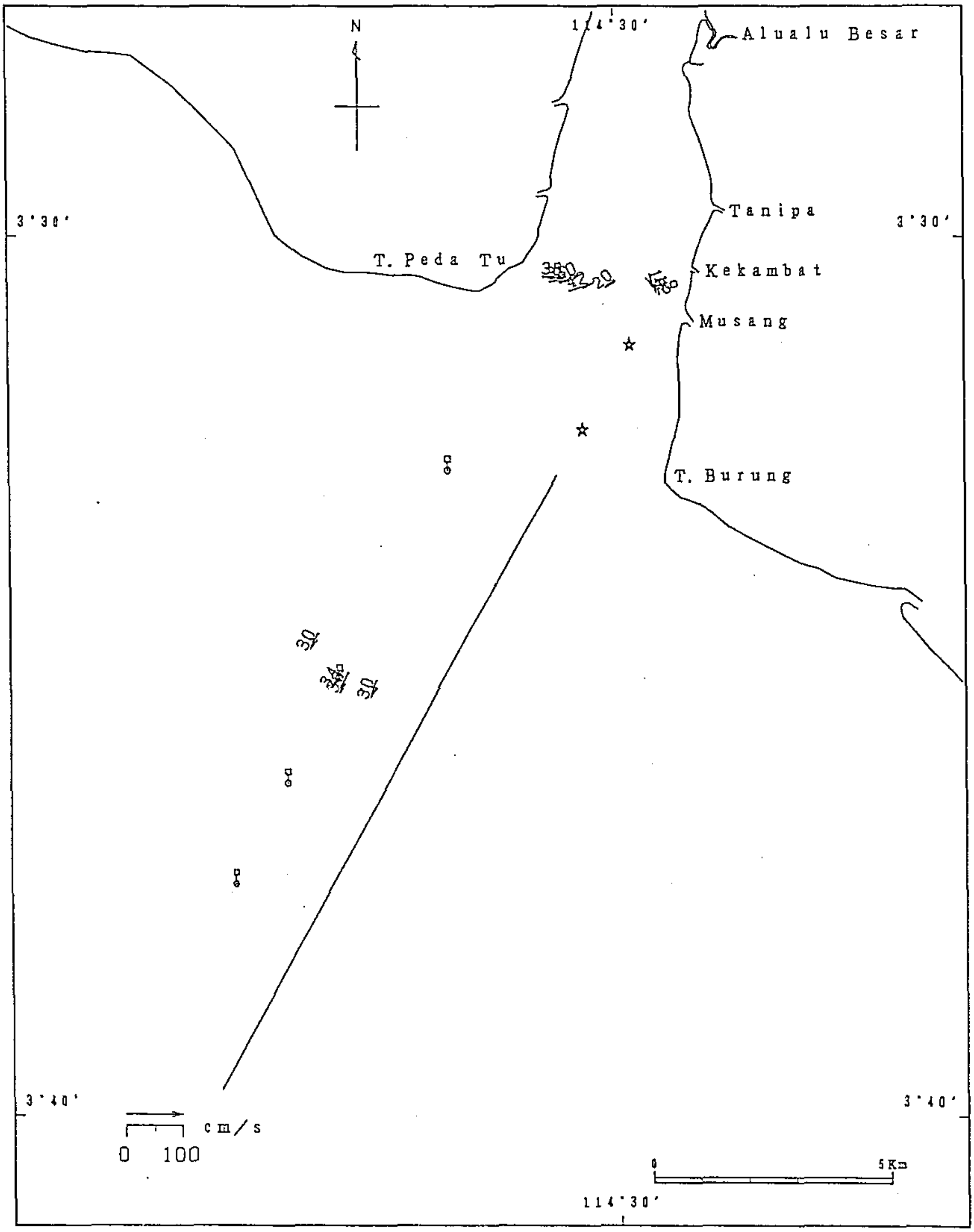


Fig. 5.3.3 − 2 (31) Current Obtained by Buoy Tracking Survey (2 hours after H.W)
(3rd General Survey)

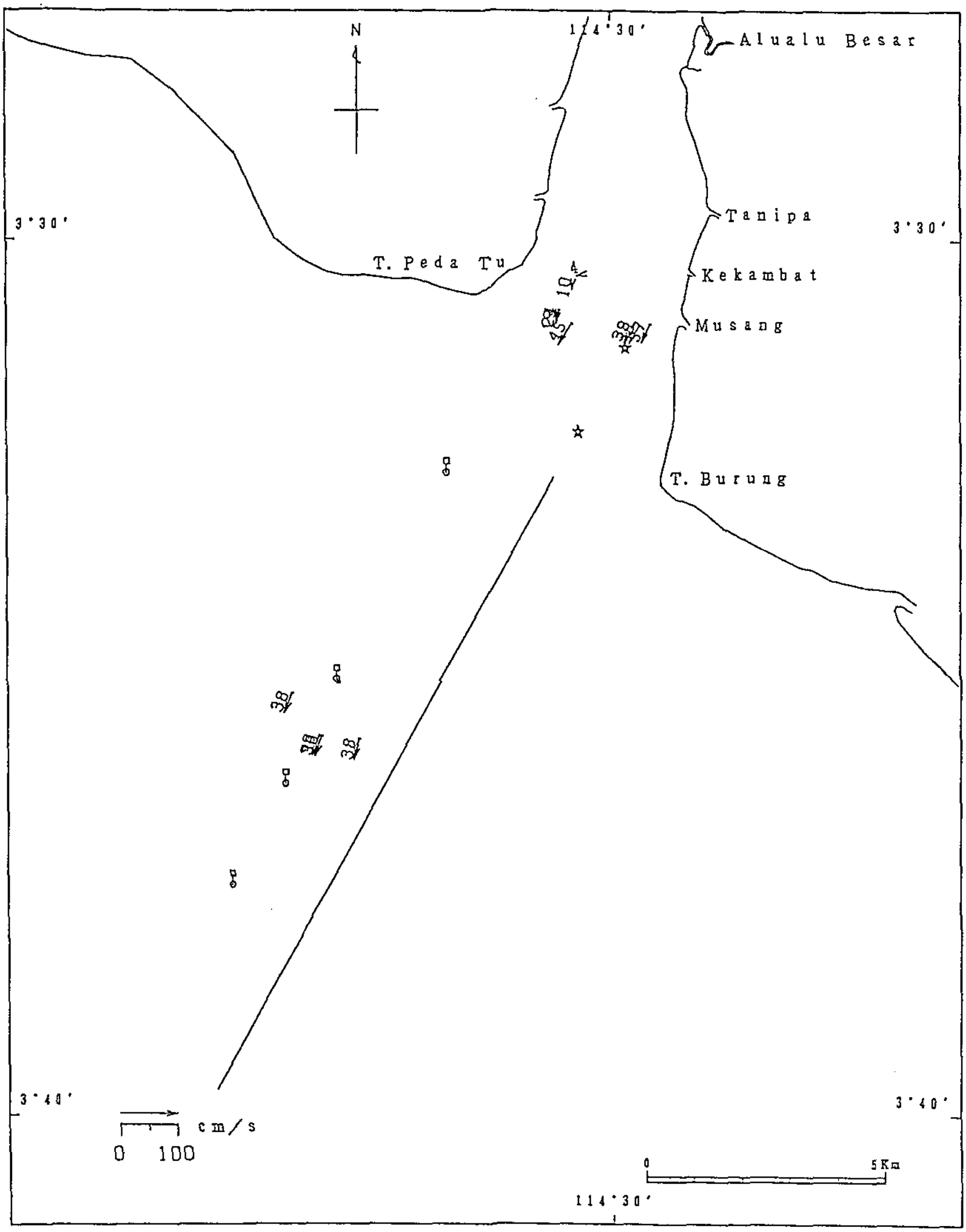


Fig. 5.3.3 - 2 (32) Current Obtained by Buoy Tracking Survey (3 hours after H.W) (3rd General Survey)

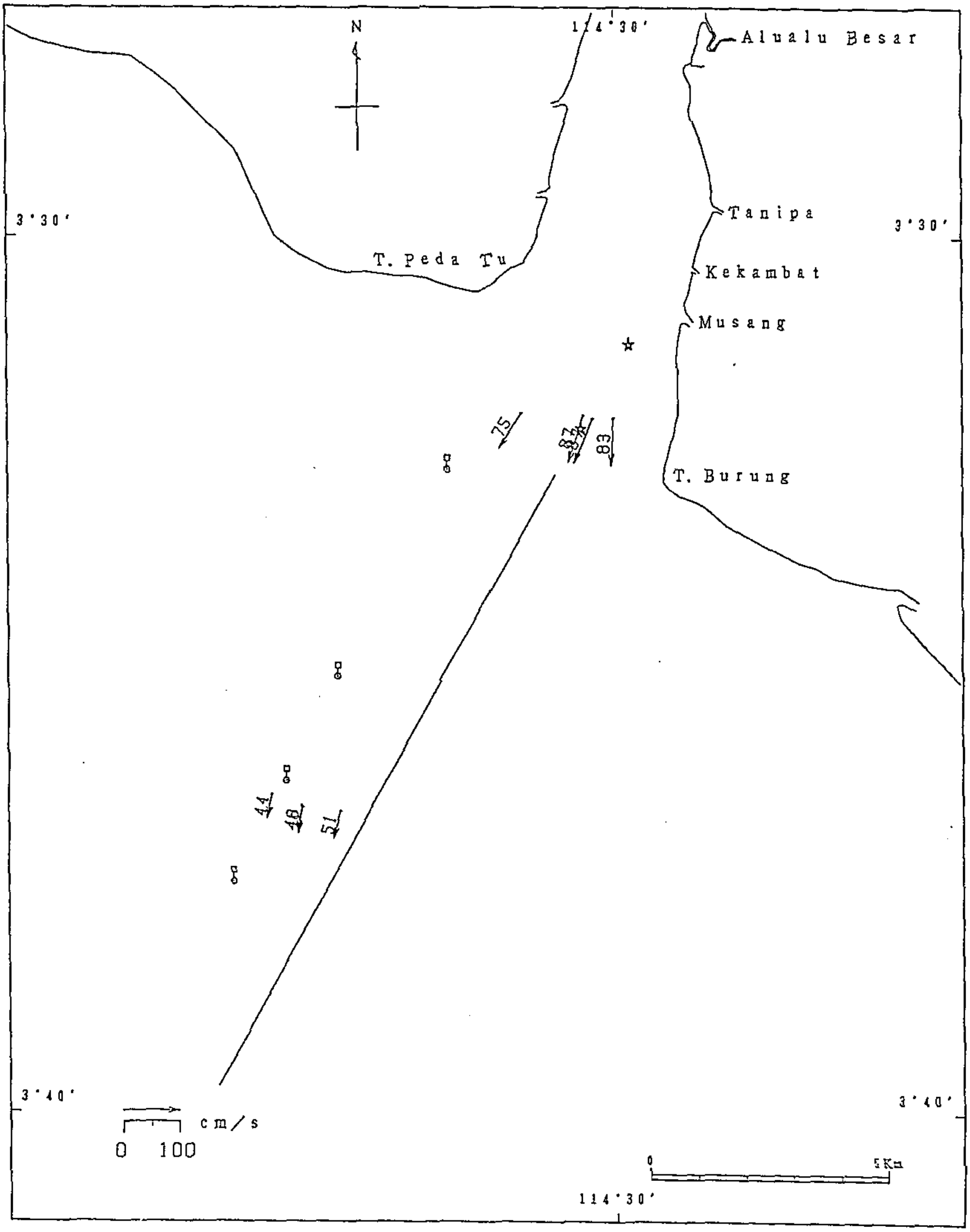


Fig. 5.3.3 − 2 (33) Current Obtained by Buoy Tracking Survey (4 hours after H.W)
(3rd General Survey)

5.3.4 Current Velocity and Turbidity

The observed water temperature, SS , current vector and results of SS which had been measured by Owen Tube were shown in the data file in volumes.

5.3.5 Bottom Materials, Salinity and Suspended Solid

1) Bottom Materials

When carrying out the General Surveys, the bottom materials were sampled over the estuary area and tested. Number of sampling stations total 26 from St.A to Z, and the test items were the grain size distribution, water content, ignition loss and shear strength.
The survey periods were as follows:

1st	General Survey:	9th Sep. to 13th Sep.1988
2nd	"	:21st Feb. to 23rd Feb.1989
3rd	"	:16th Apr. to 19th Apr.1989.

A composition of the bottom materials is represented in a circular graph consisting of the gravel, sand, silt and clay. The bottom materials are classified by sand contents basing upon the Japanese Unified Soil Classification System as follows:

I : F, fine-grained soil(sand<25%)

I' : F, fine-grained soil(sand<50%)

II : (SF), sandy soil(50<sand<85%)

III : (S-F), fine-grained mixed sand(85<sand<95%).

Distributions and variation conditions of the bottom materials in the estuary area are summarized as follows:

1st General Survey

At St.C where locates in a dried up area in front of the west coast, the sand content shows the maximum value of 92%, so this area belongs to a type of III. A type of II distributes around st.Q with sand content of 77 % and St.O with sand content of 54% in the area of both side of the access channel in the offing.
A type of I' distributes on the west side area, and a type of I distributes from the estuary to the east side of the access channel and the offing. The type of I' seems to be distribute nearly corresponding to an area with water depth shallower than 2m. (cf.Fig.5.3.5-1)

2nd General Survey

The type of II with sand content exceeding 50% distributes on both sides of middle part of the access channel as well as the 1st General Survey.
However, in the st.C belonged to III type in the 1st General Survey, sand content decreased and clay content decreased and the type changed to I' in this time of survey in rainy season.
And also in St.B in Estuary area, sand content decreased from I' to I and clay content increased to about 45%.
An area of the type of I' distributes in a shallow sea area centering the estuary area with a shape of semi-circle as well as the 1st General Survey.
An area distributing on the east of the estuary and the most offing area also belong to the type of I as well as the 1st General Survey.(cf.Fig.5.3.5-2)

3rd General Survey

In this time of survey carried out end of rainy season, sand distribution condition not changed so much in whole comparing with 2nd General survey but local changes were partly found.

At St.H in front of the east coast of the estuary area, sand content increases to 75 %, and this area changes into the type of II area.
A type of II area distributes around St.O and St.L on both sides of the access channel.
A distribution area of the type of I' is a little narrower than that in the 2nd General Survey, but an area including St.C or St.I in front of the west coast belongs to the type of I. Areas including St.Q and St. X on the east of the access channel also belong to the type of I'.(cf.Fig.5.3.5-3)

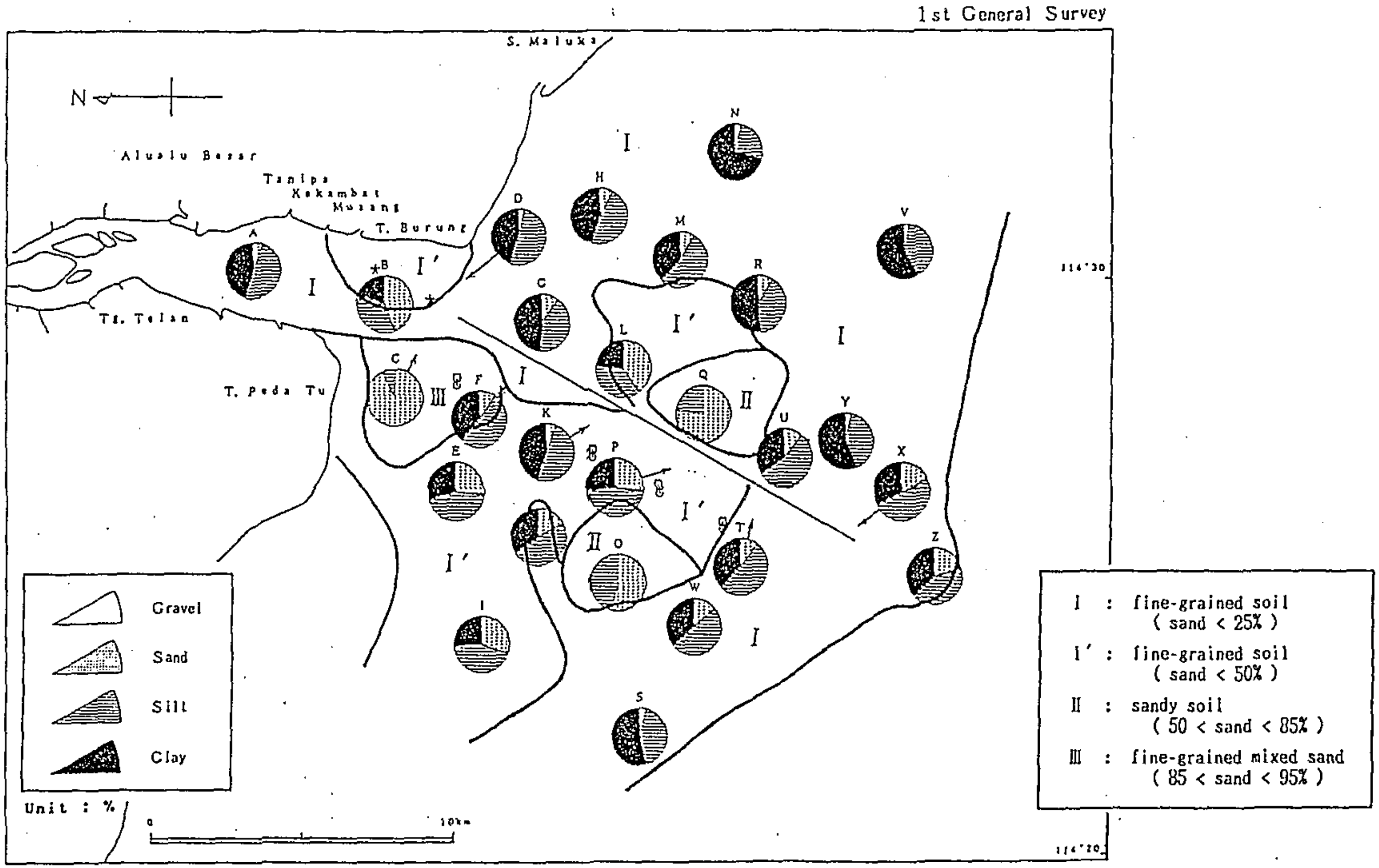


Fig. 5.3.5-1 Grain Size Distribution of Bottom Material

2nd General Survey

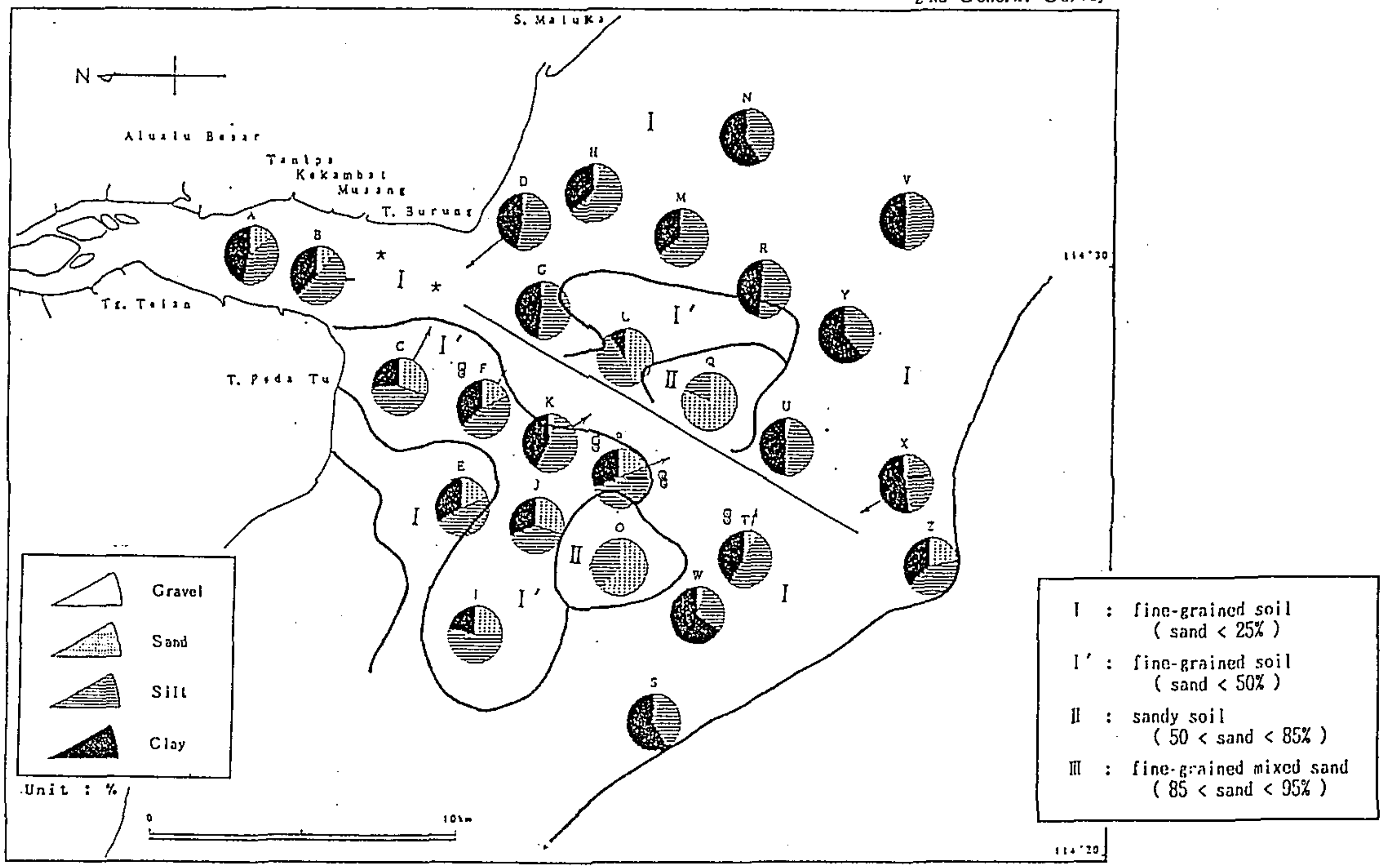


Fig. 5.3.5-2 Grain Size Distribution of Bottom Material

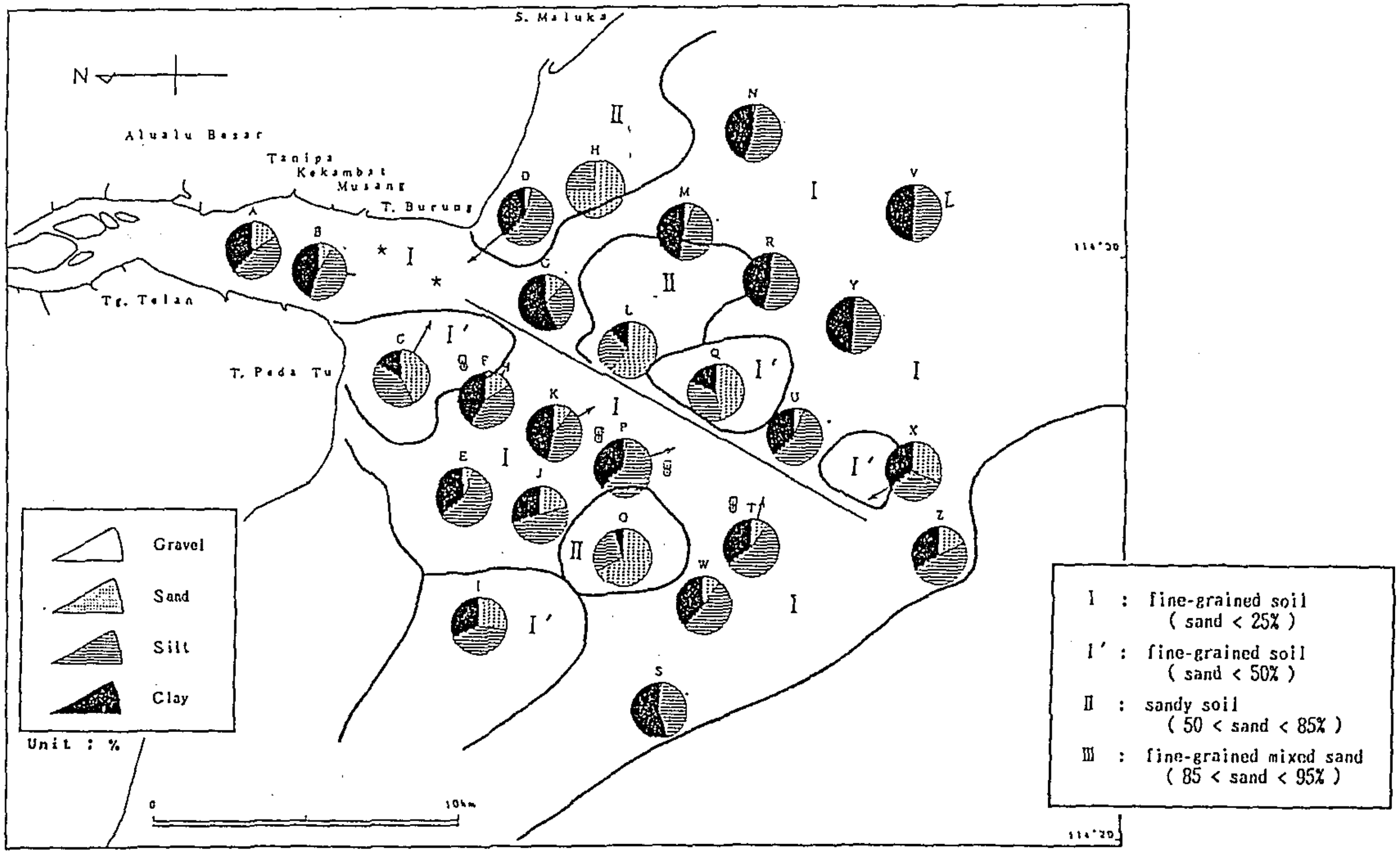


Fig. 5.3.5-3 Grain Size Distribution of Bottom Material

1st General Survey

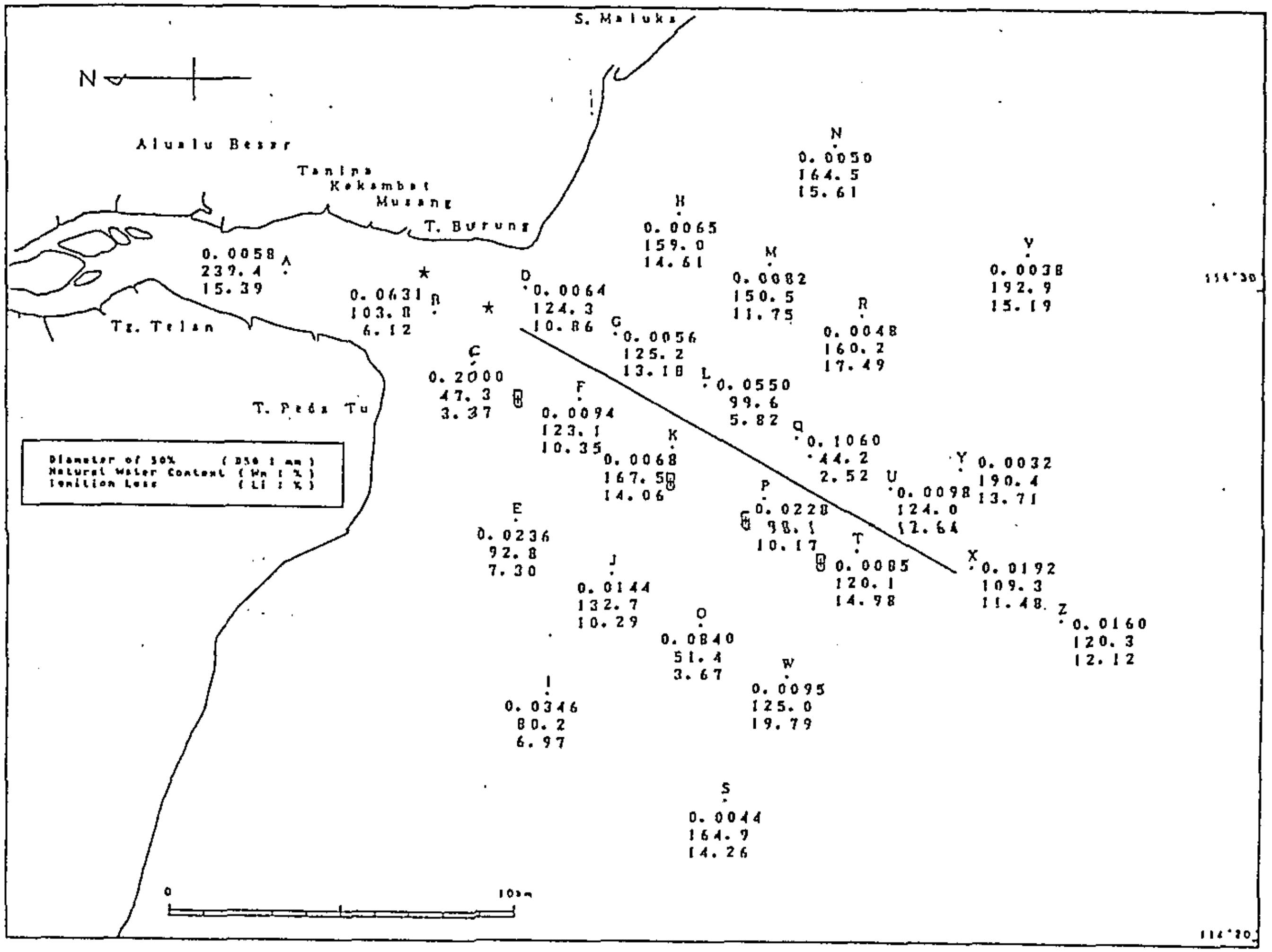


Fig. 5.3.5-4 Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

2nd General Survey

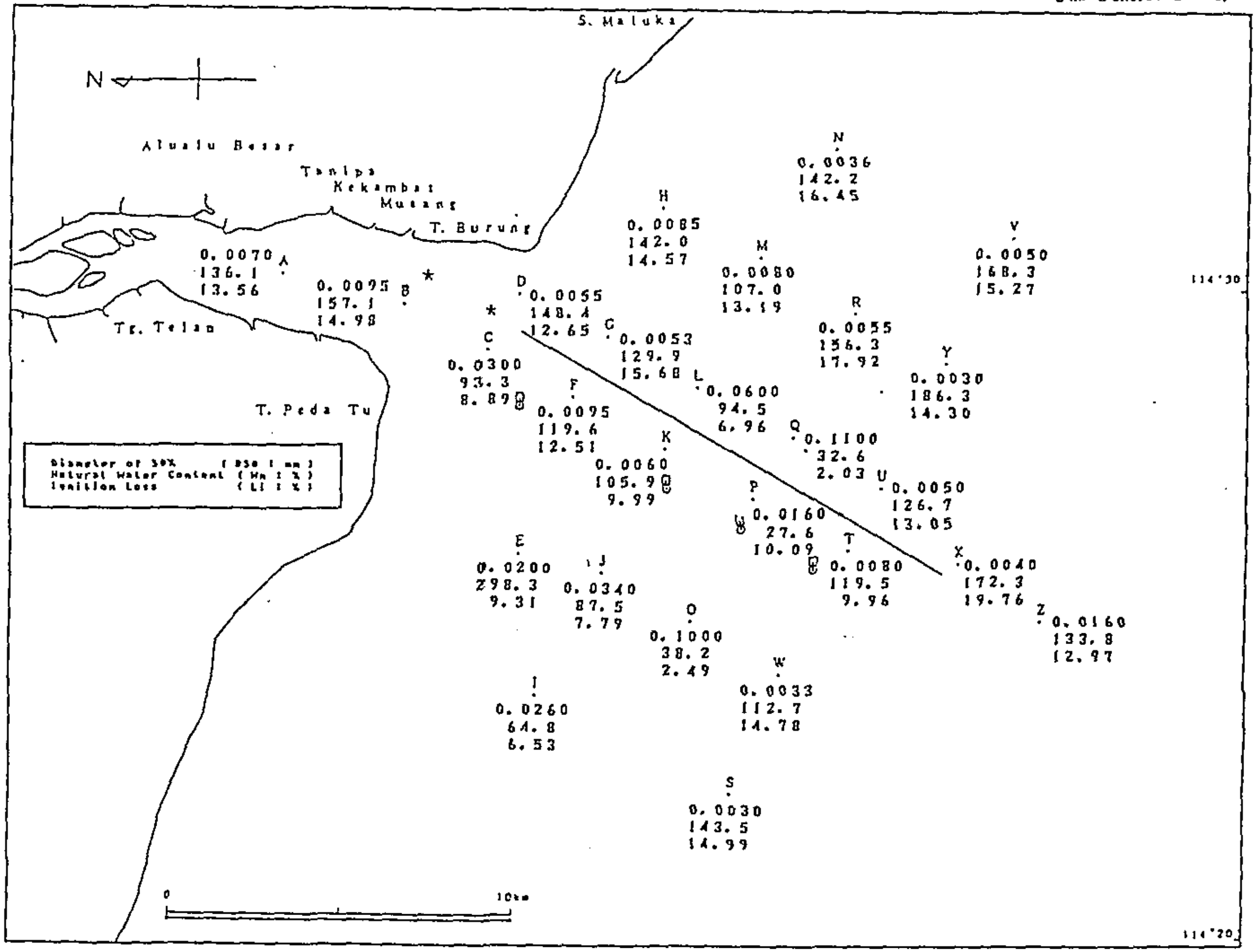


Fig. 5.3.5-5 Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

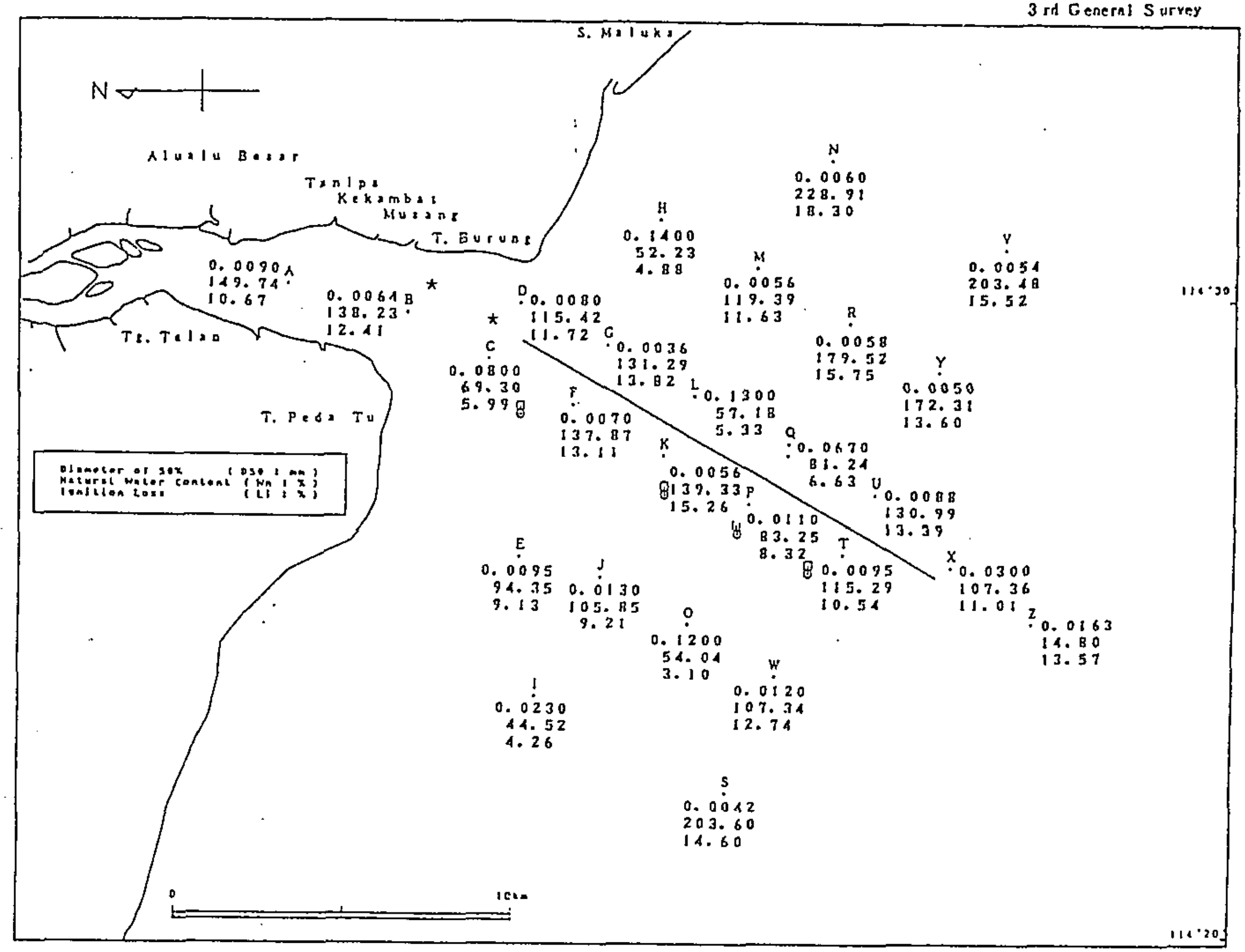


Fig. 5.3.5-6 Diameter of 50%, Natural Water Content and Ignition Loss of Botom Material

1st General Survey

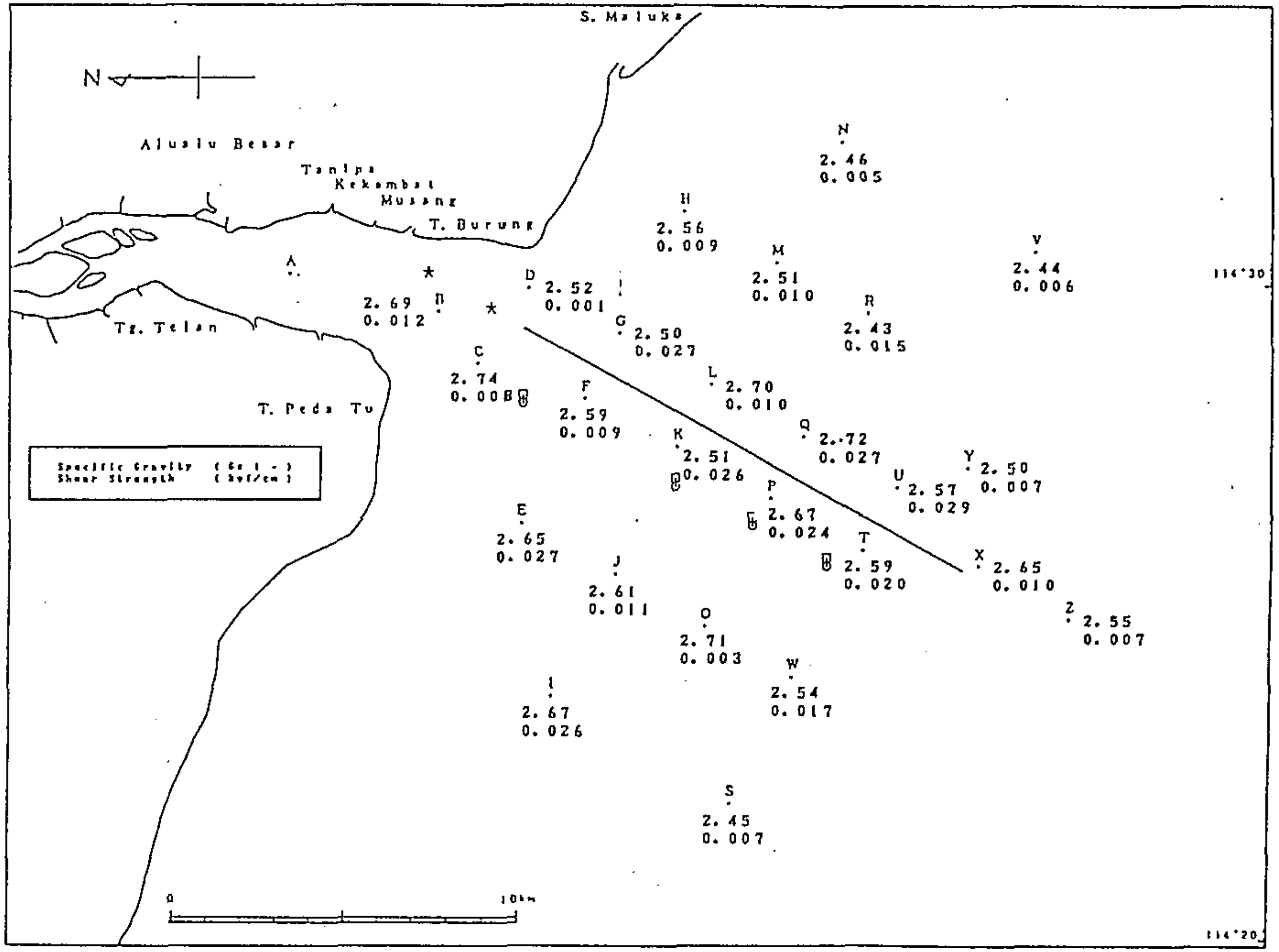


Fig. 5.3.5-7 Specific Gravity and Shear Strength

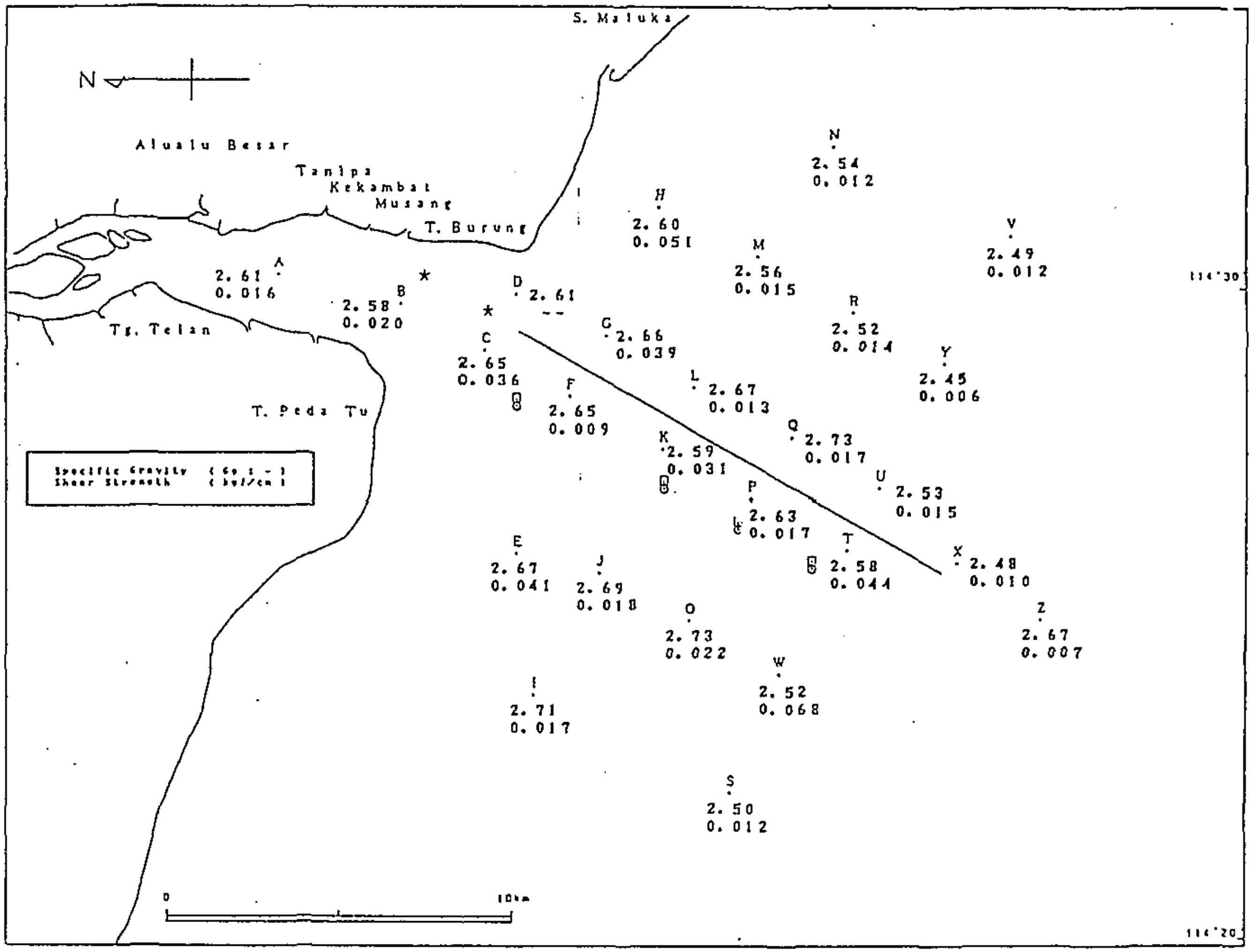


Fig. 5.3.5-8 Specific Gravity and Shear Strength

3rd General Survey

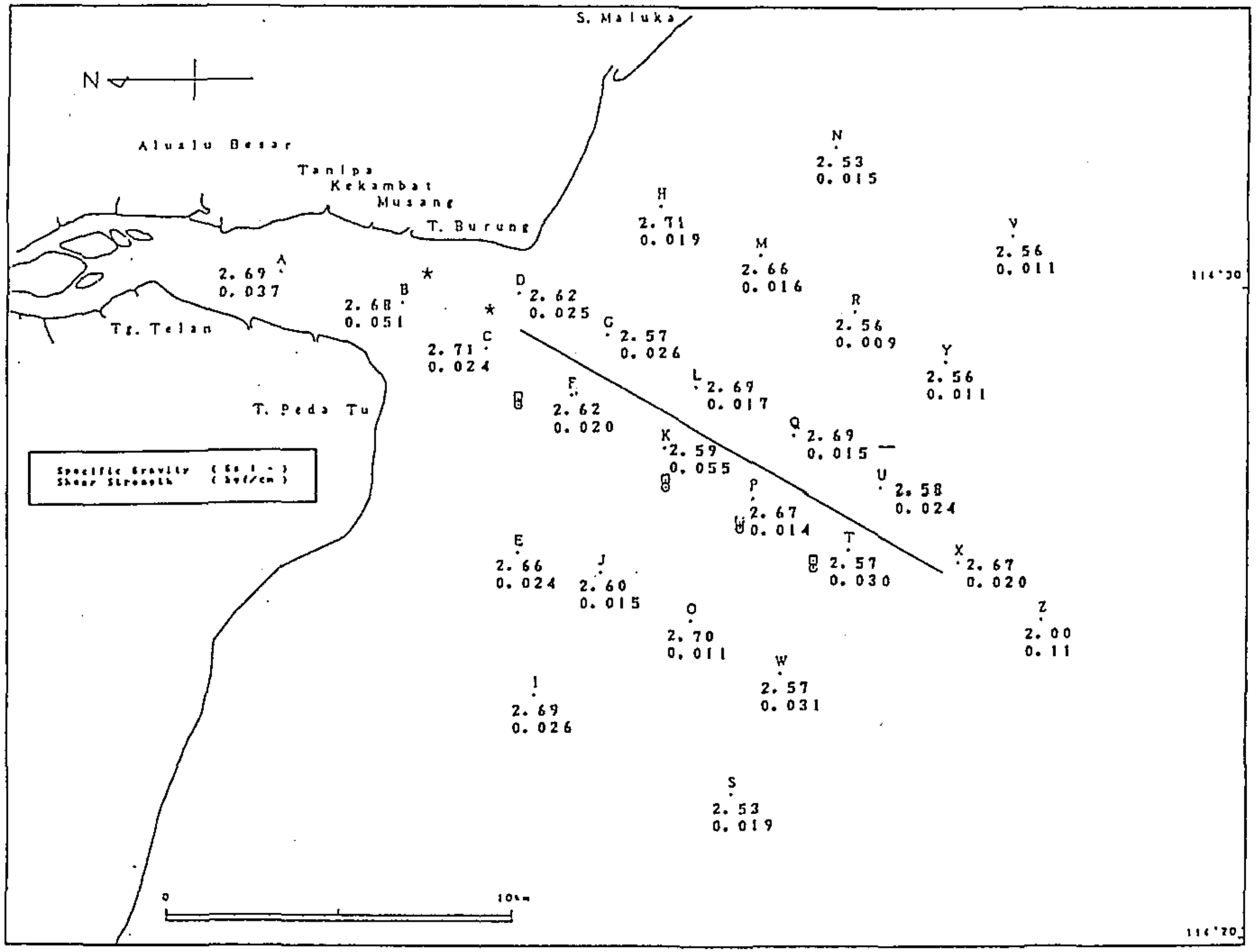


Fig. 5.3.5-9 Specific Gravity and Shear Strength

Survey Date : 9th Sep. 1988
Layer : 0.5m Under Seasurface
Unit : Temp. (℃)

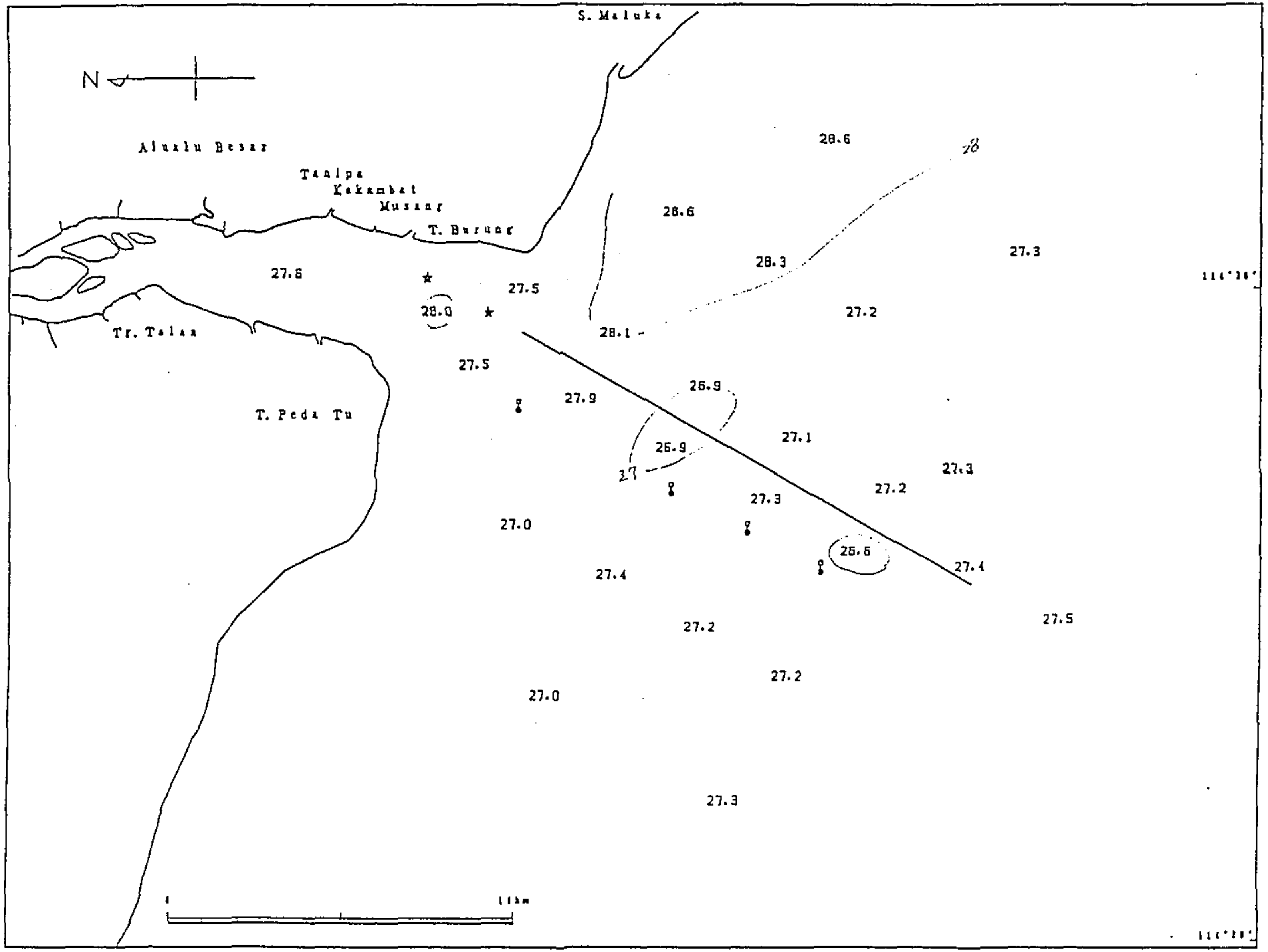


Fig. 5.3.5-10 (1) Horizontal Distribution of Water Temperature
(1st General Survey)

Survey Date : 9th Sep. 1988
Layer : 0.5m Above Seabed
Unit : Temp. (℃)

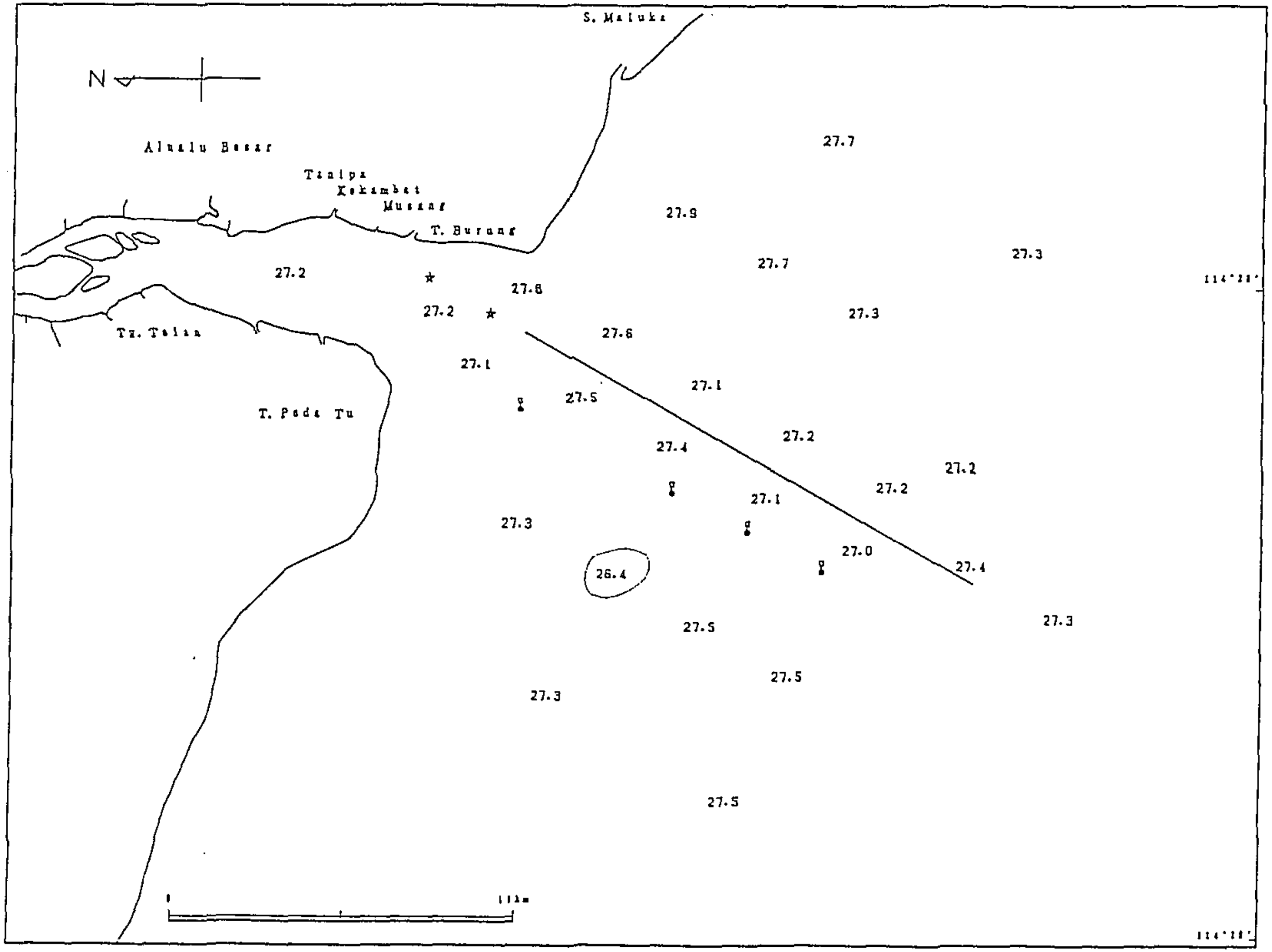


Fig. 5.3.5 −10 (2) Horizontal Distribution of Water Temperature
(1st General Survey)

Survey Date : 21th Feb. 1989
Layer : 0.5m Under Seasurface
Unit : Temp. (℃)

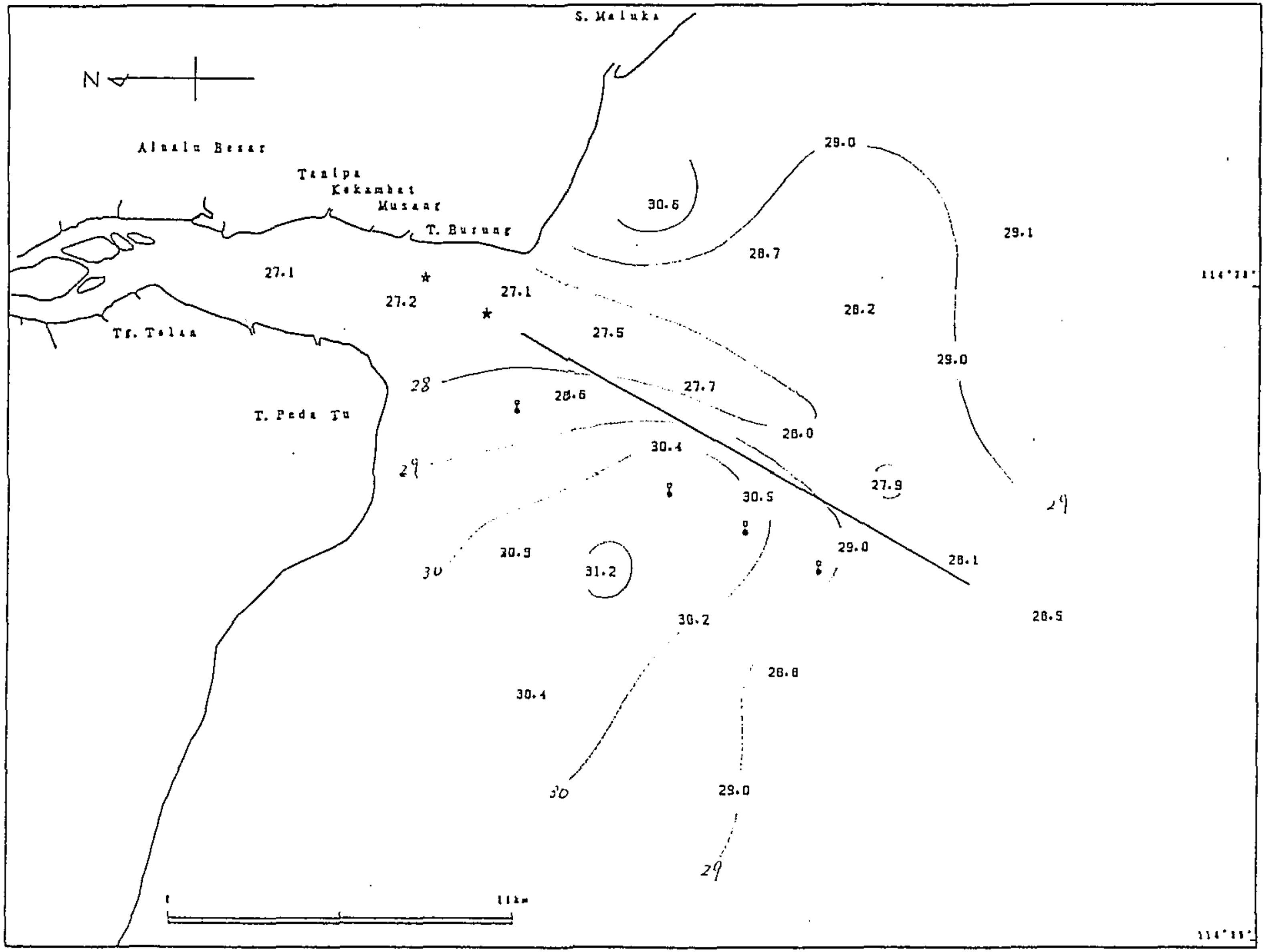


Fig. 5.3.5−10 (3) Horizontal Distribution of Water Temperature (2nd General Survey)

Survey Date : 21th Feb. 1989
Layer : 0.5m Above Seabed
Unit : Temp. (℃)

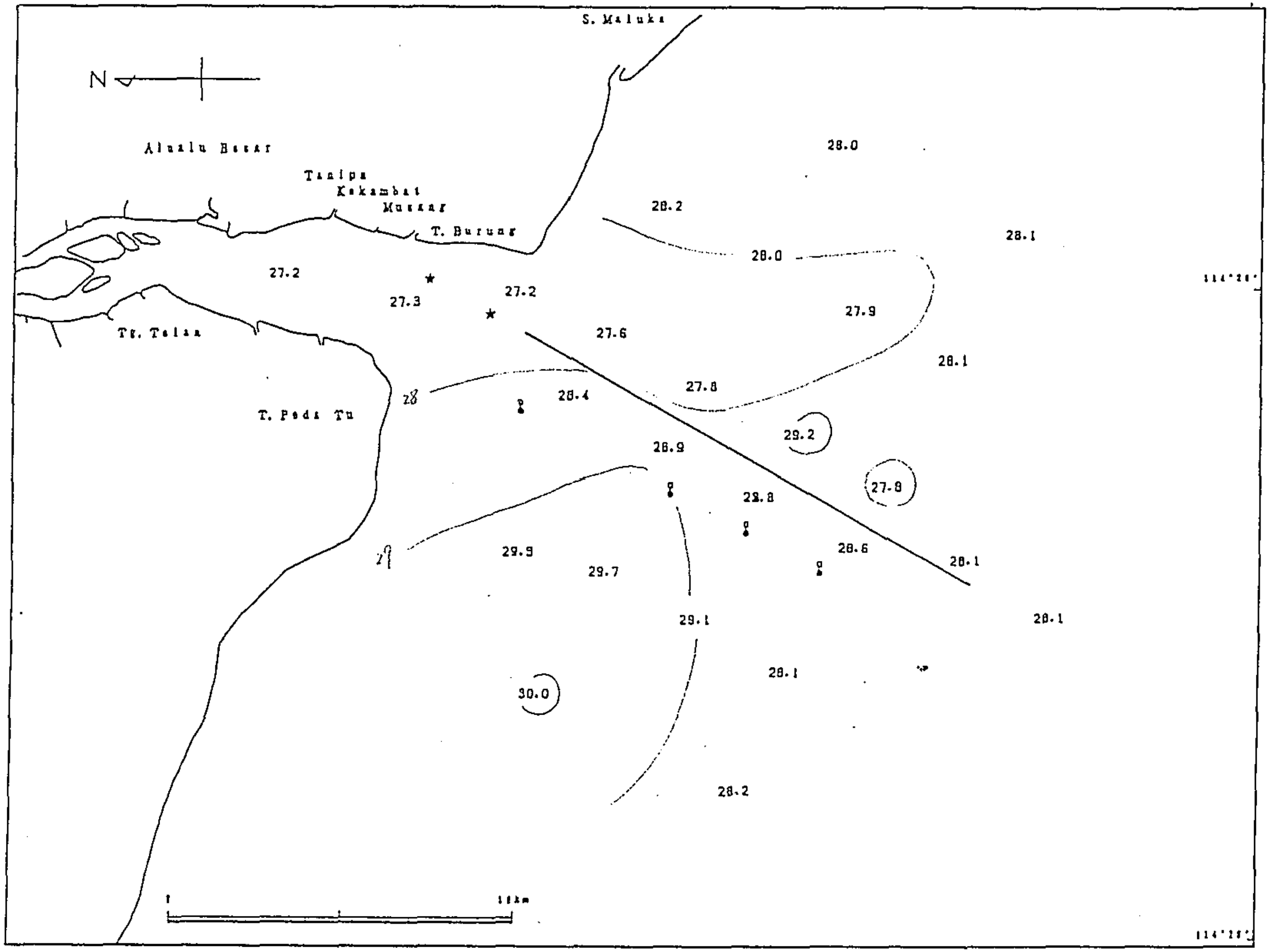


Fig. 5.3.5−10 (4) Horizontal Distribution of Water Temperature
(2nd General Survey)

Survey Date : 16th Apr. 1989
Layer : 0.5m Under Seasurface
Unit : Temp. (℃)

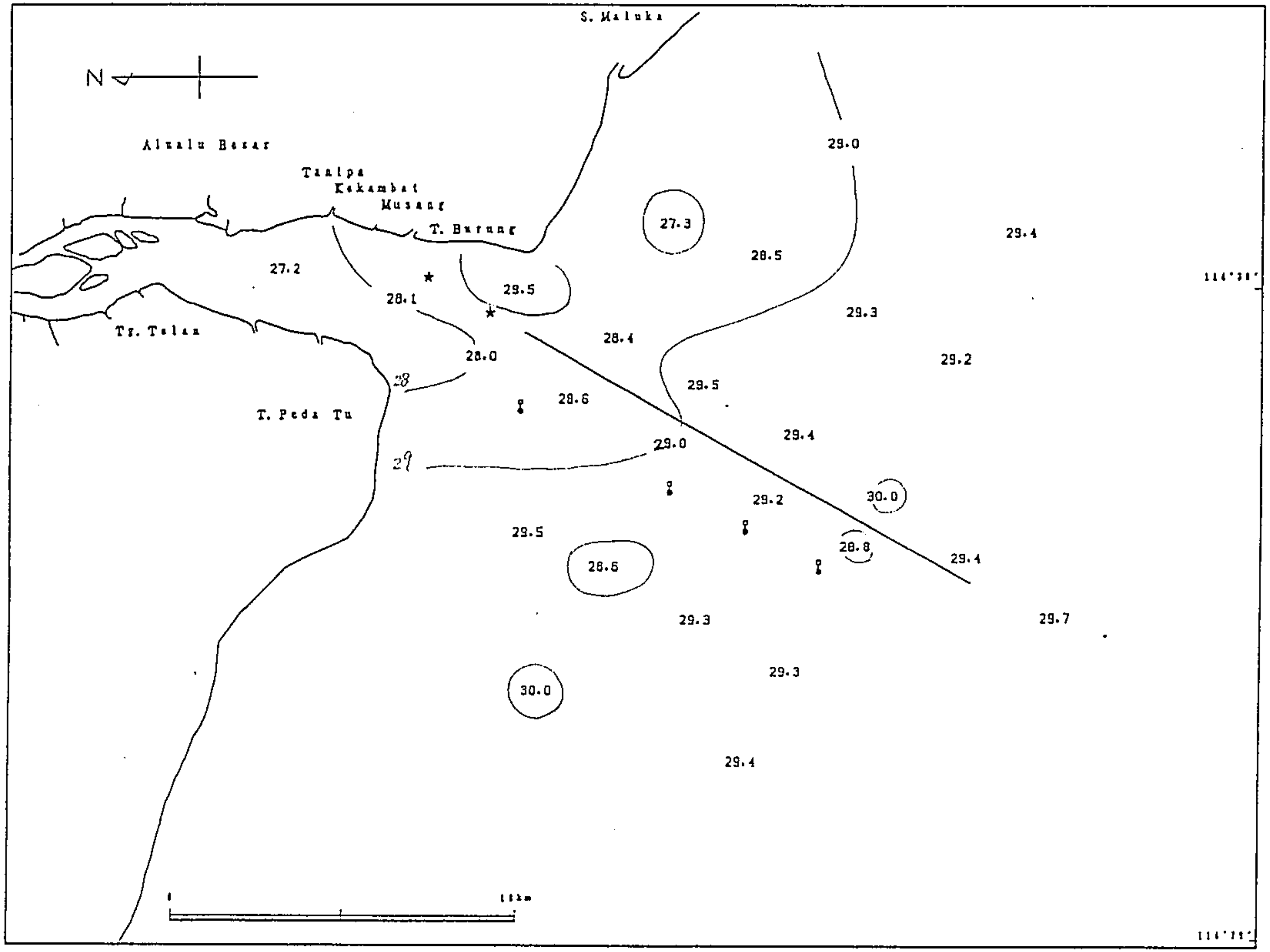


Fig. 5.3.5-10 (5) Horizontal Distribution of Water Temperature
(3rd General Survey)

Survey Date : 16th Apr. 1989
Layer : 0.5m Above Seabed
Unit : Temp. (℃)

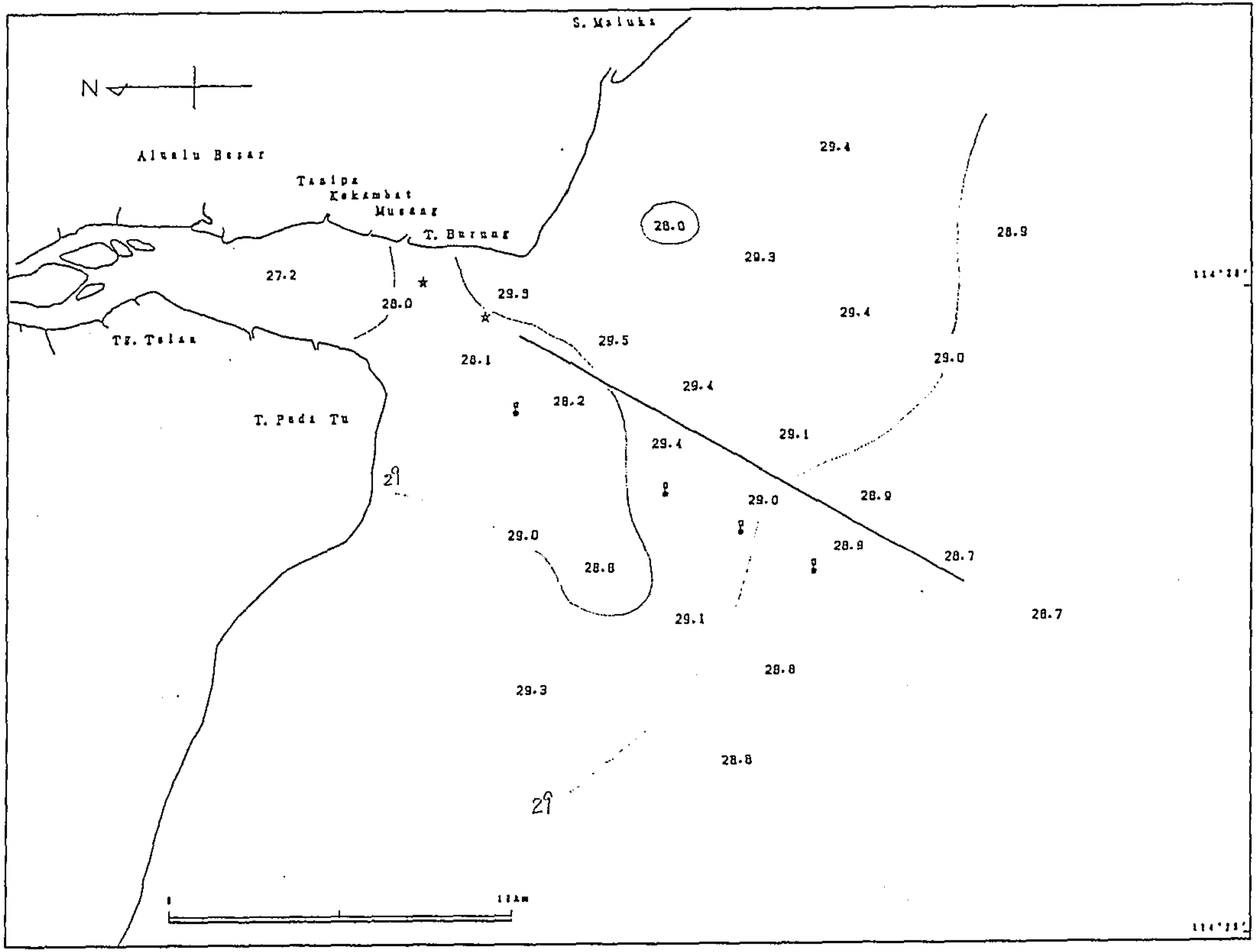


Fig. 5.3.5-10 (6) Horizontal Distribution of Water Temperature
(3rd General Survey)

Survey Date : 9th Sep. 1988
Layer : 0.5m Under Seasurface
Unit : Sal. (—)

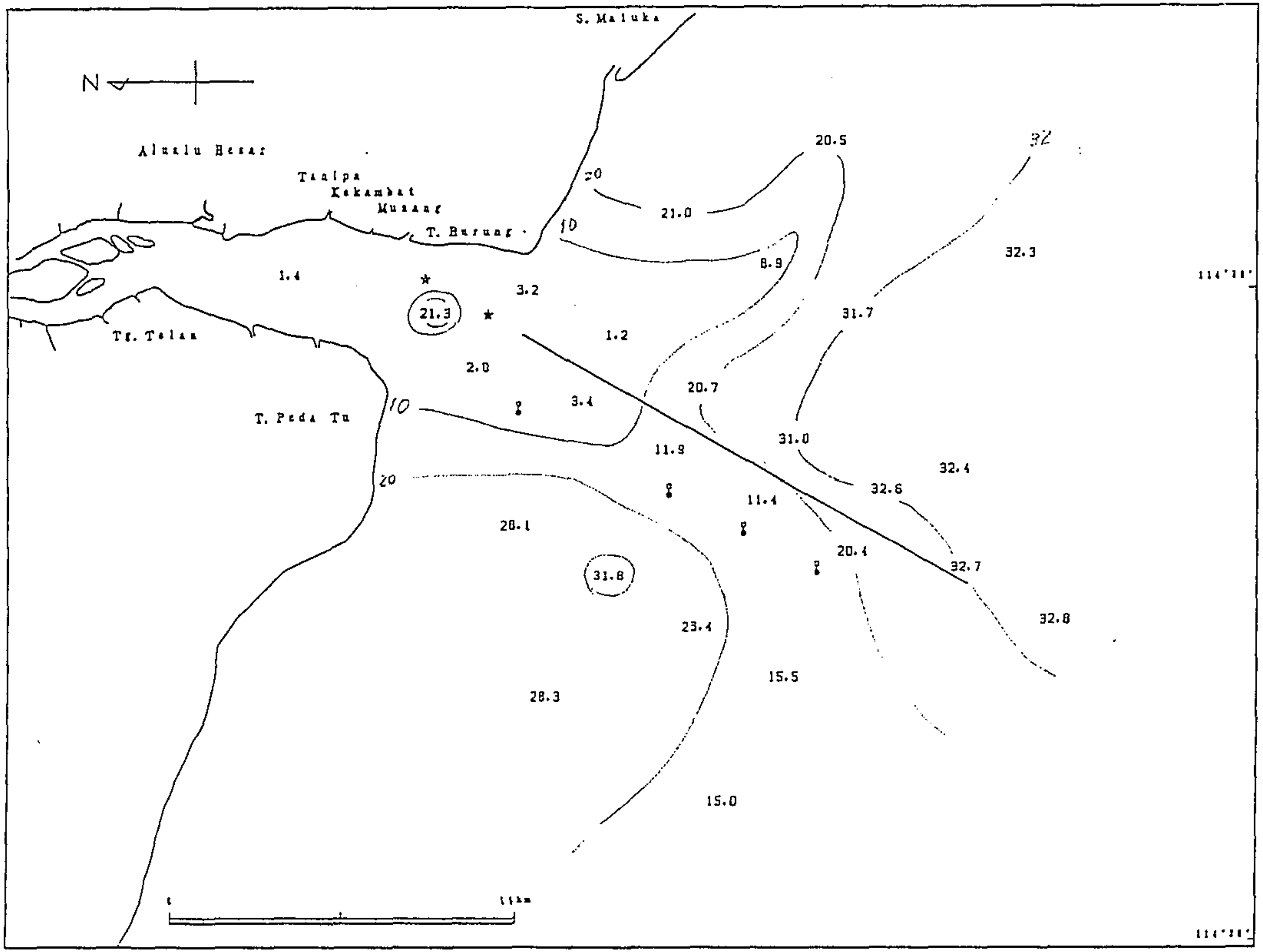


Fig. 5.3.5-11 (1) Horizontal Distribution of Salinity
(1st General Survey)

Survey Date : 9th Sep. 1988
Layer : 0.5m Above Seabed
Unit : Sal. (−)

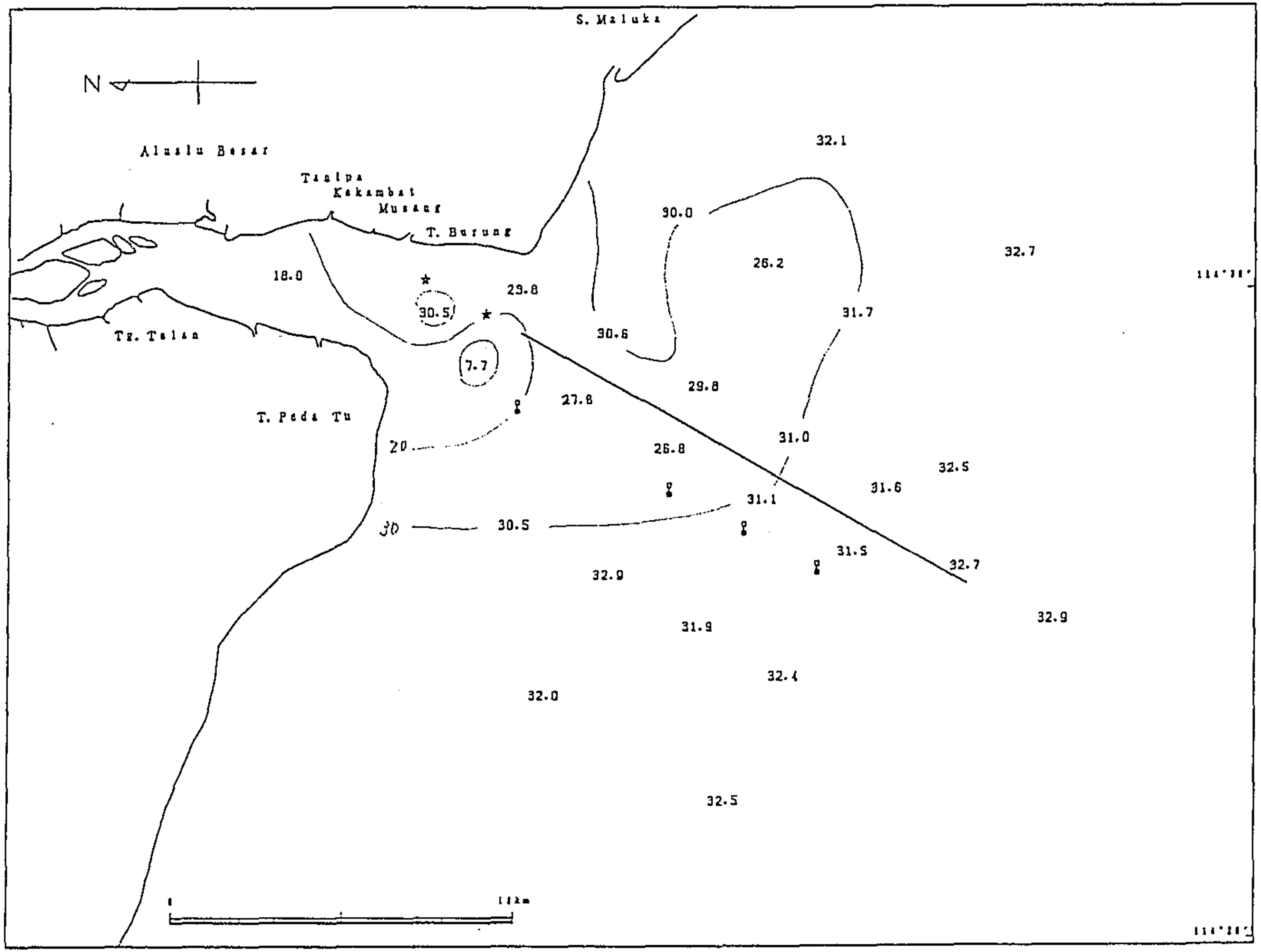


Fig. 5.3.5−11 (2) Horizontal Distribution of Salinity
(1st General Survey)

Survey Date : 21th Feb. 1989
Layer : 0.5m Under Seasurface
Unit : Sal. (—)

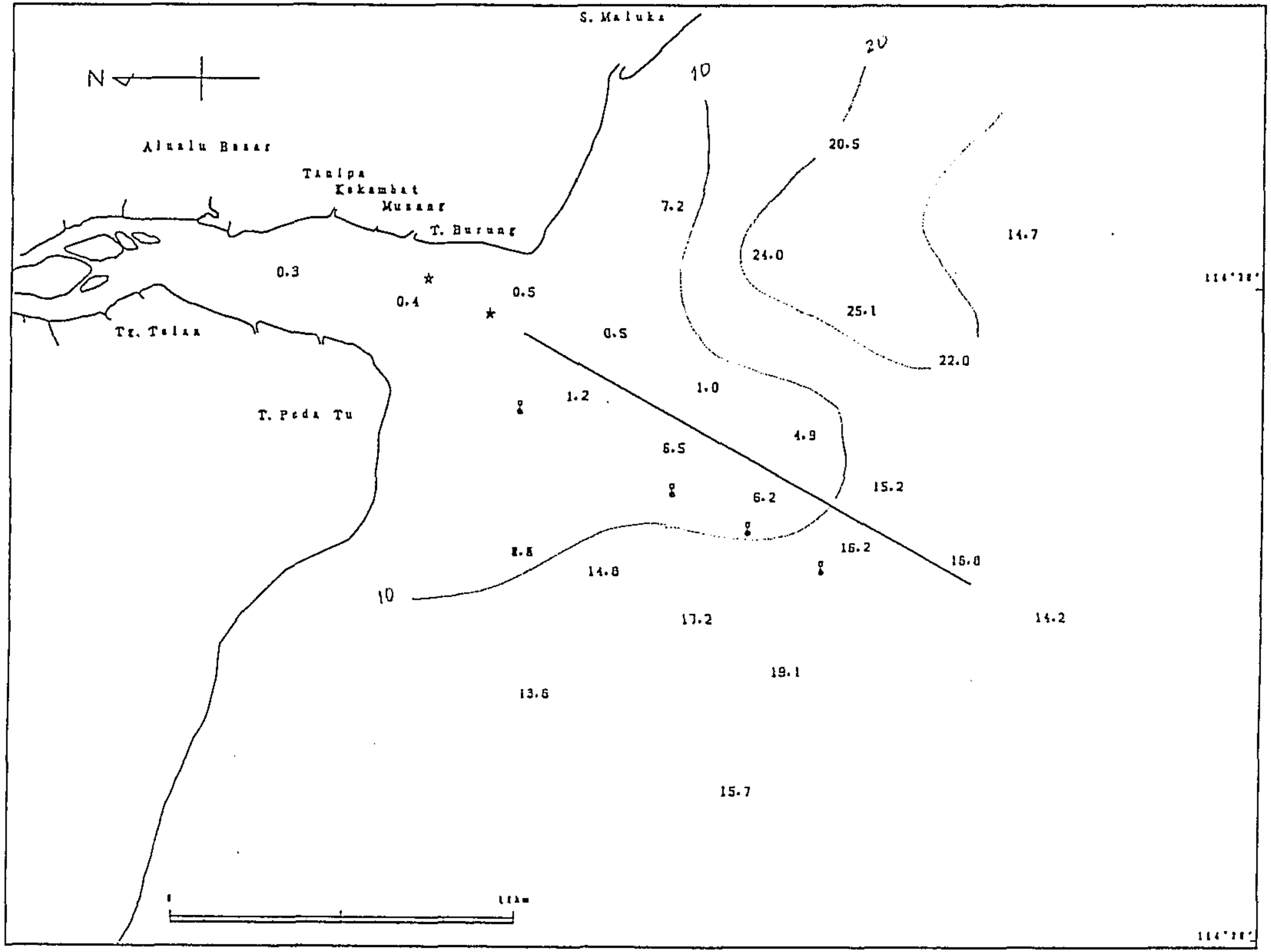


Fig. 5.3.5 −11 (3) Horizontal Distribution of Salinity
(2nd General Survey)

Survey Date : 21th Feb. 1989
Layer : 0.5m Above Seabed
Unit : Sal. (−)

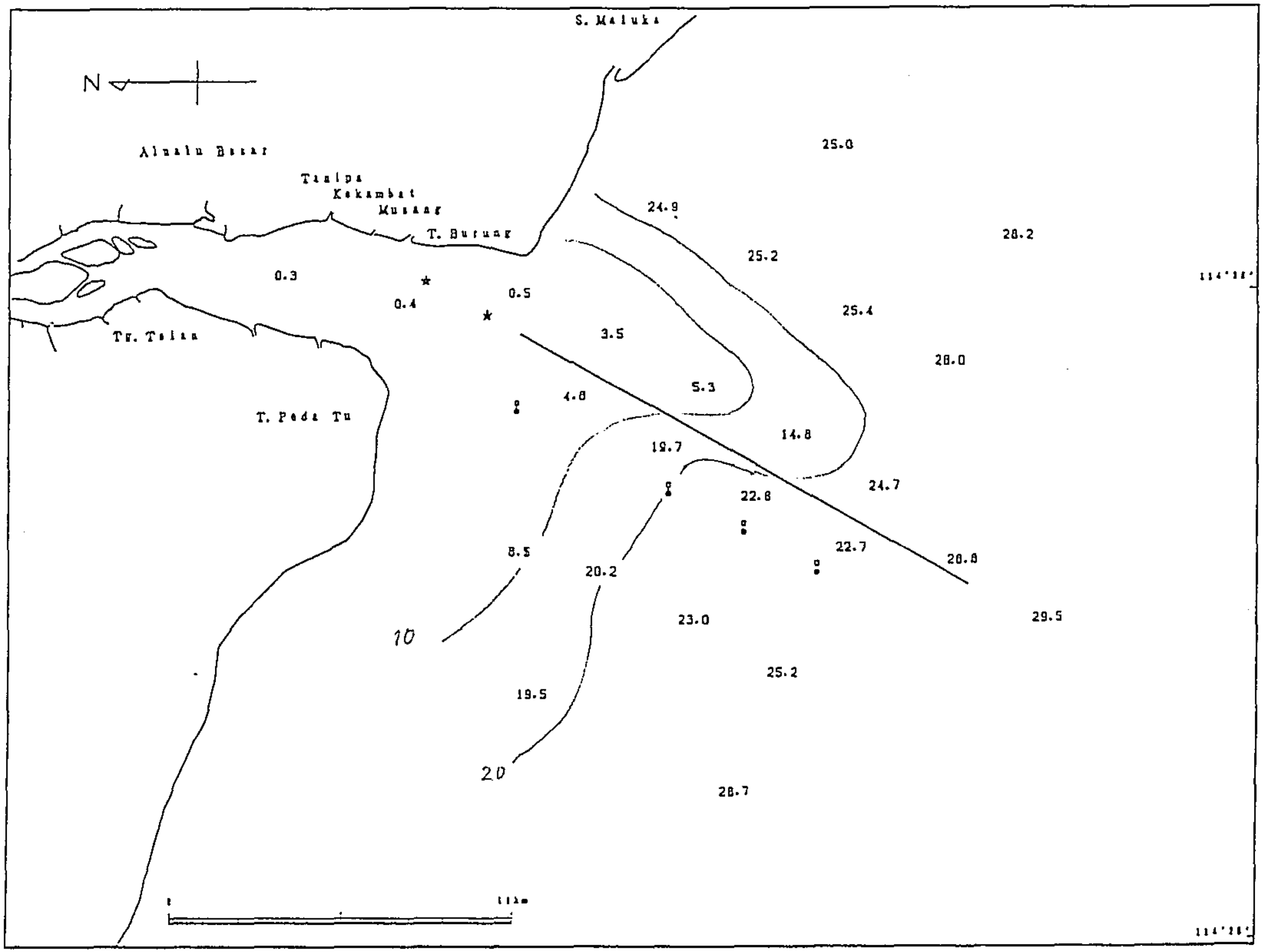


Fig. 5.3.5−11 (4) Horizontal Distribution of Salinity
(2nd General Survey)

Survey Date : 16th Apr. 1989
Layer : 0.5m Under Seasurface
Unit : Sal. (−)

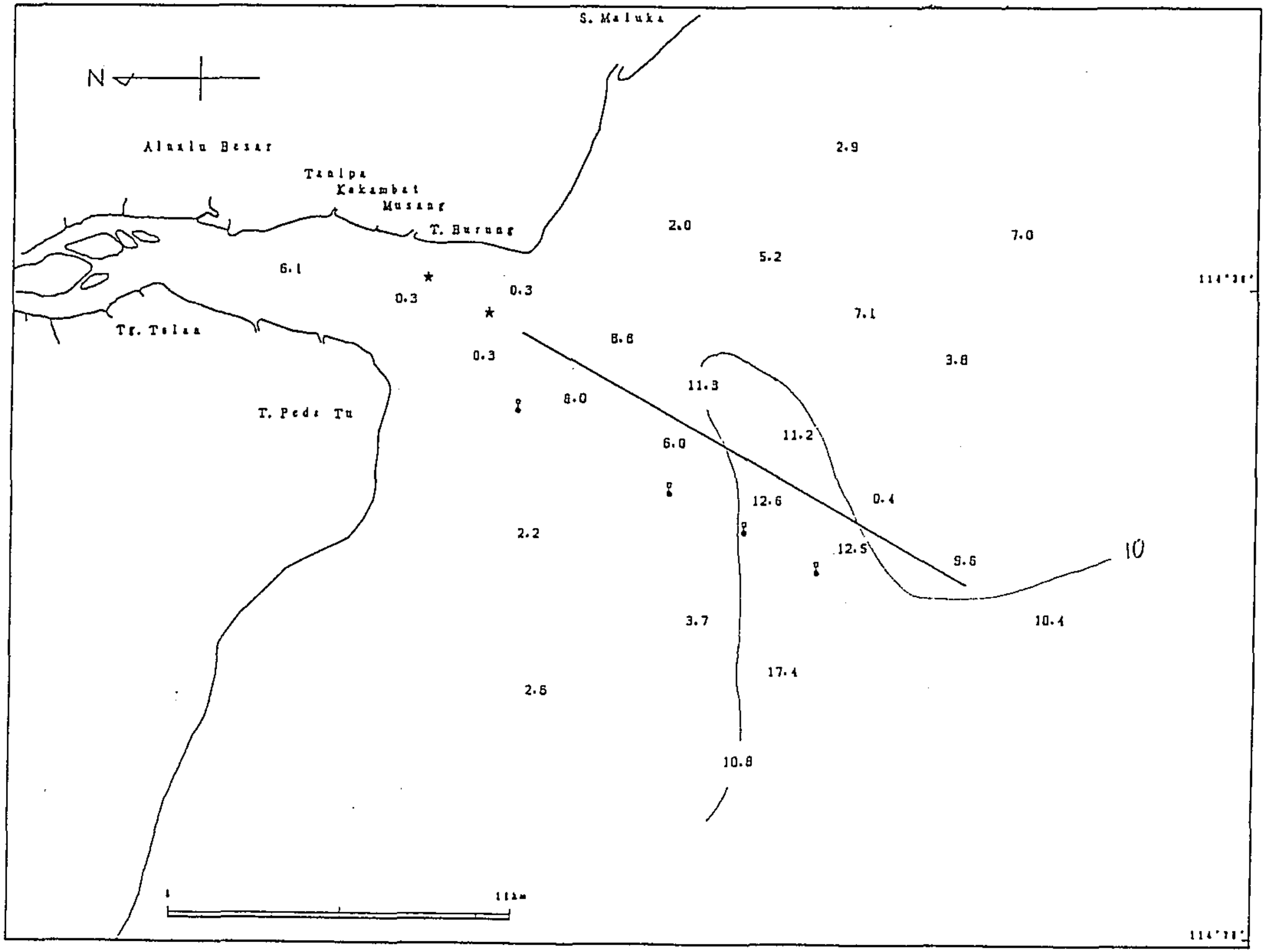


Fig. 5.3.5−11 (5) Horizontal Distribution of Salinity
(3rd General Survey)

Survey Date : 16th Apr. 1989
Layer : 0.5m Above Seabed
Unit : Sal. (–)

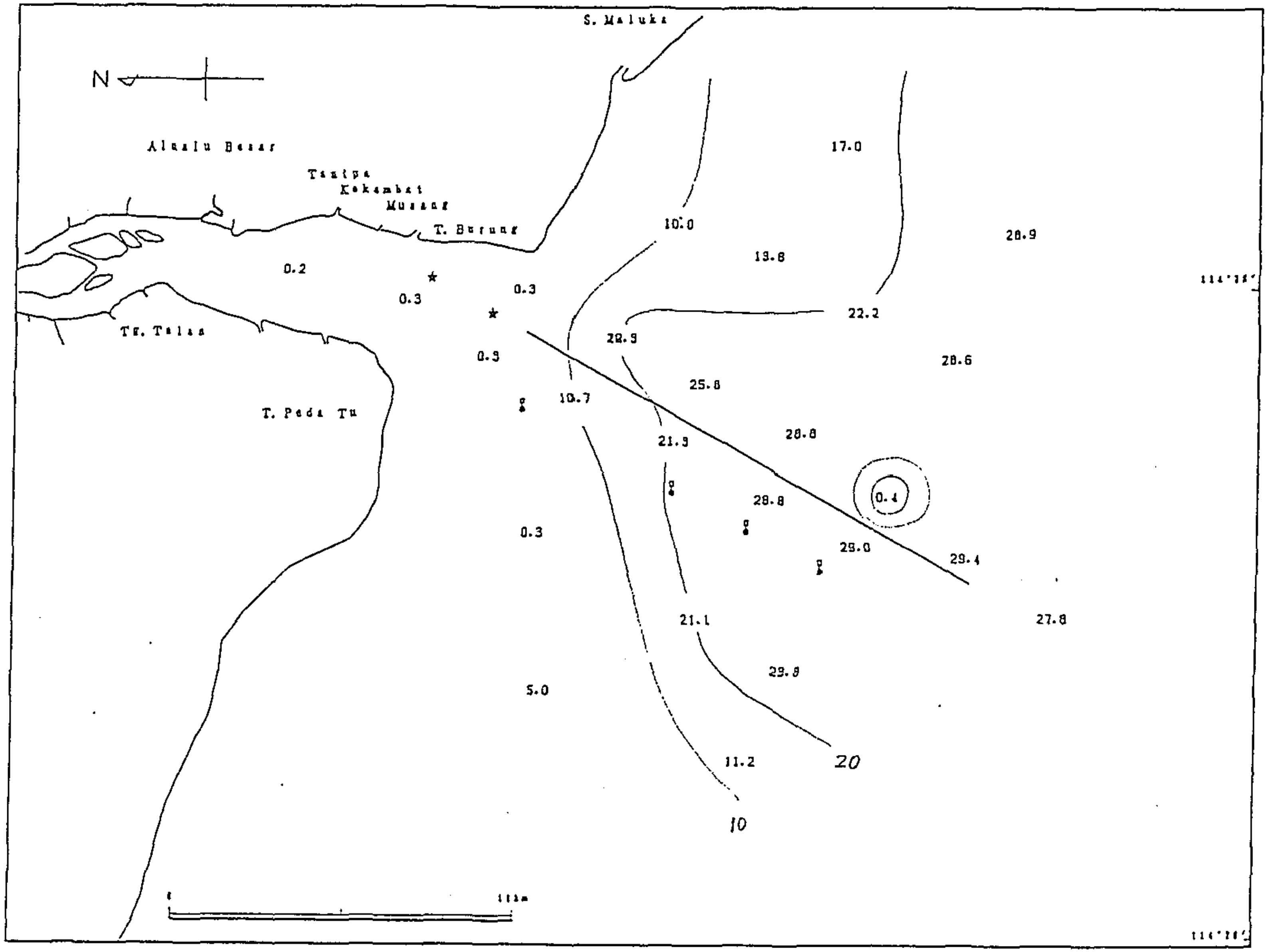


Fig. 5.3.5 –11 (6) Horizontal Distribution of Salinity
(3rd General Survey)

Survey Date : 9th Sep. 1988
Layer : 0.5m Under Seasurface
Unit : SS (mg/ℓ)

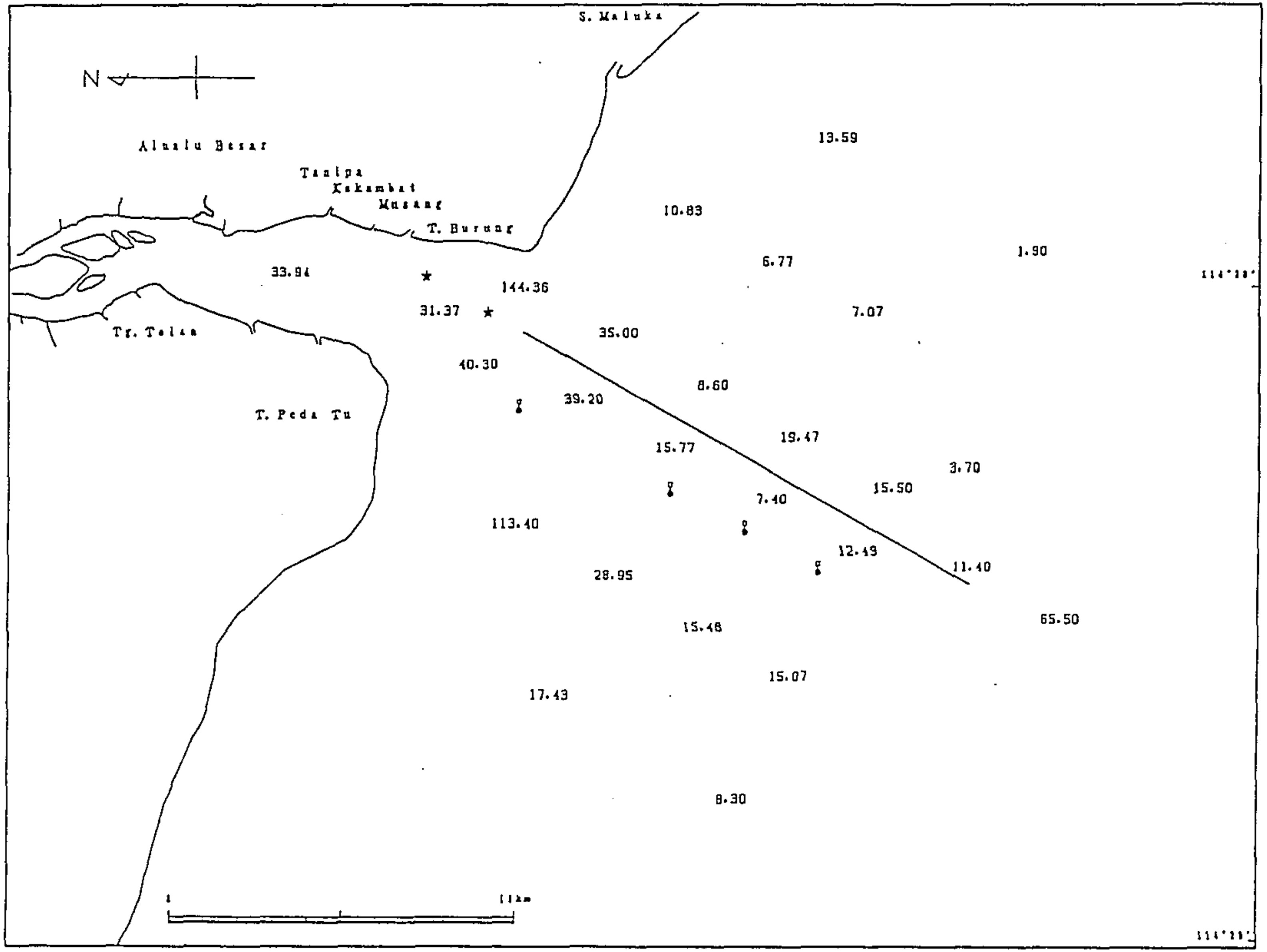


Fig. 5.3.5-12 (1) Horizontal Distribution of SS
(1st General Survey)

Survey Date : 9th Sep. 1988
Layer : 0.5m Above Seabed
Unit : SS (mg/ℓ)

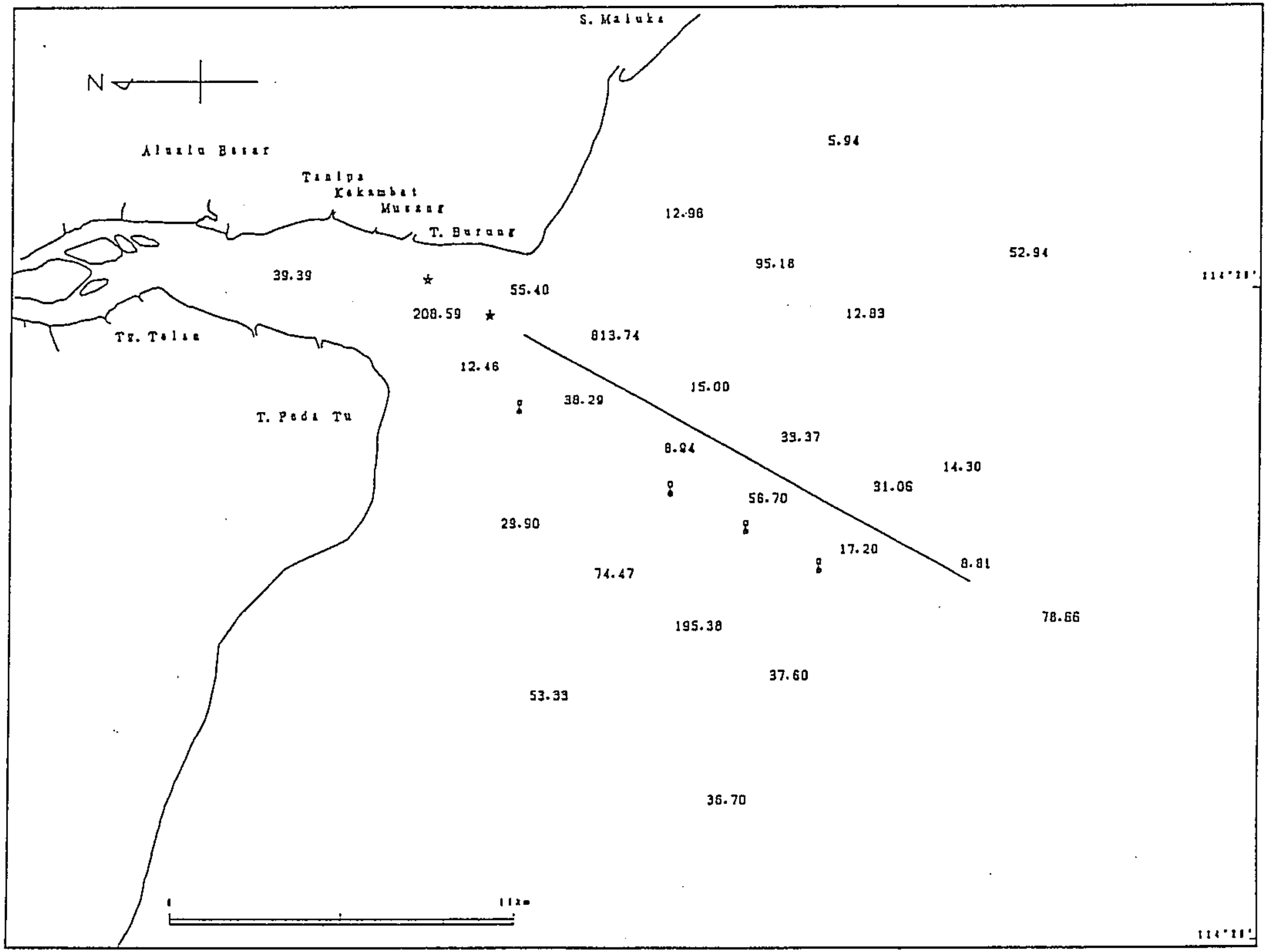


Fig. 5.3.5-12 (2) Horizontal Distribution of SS
(1st General Survey)

Survey Date : 21th Feb. 1989
Layer : 0.5m Under Seasurface
Unit : SS (mg/ℓ)

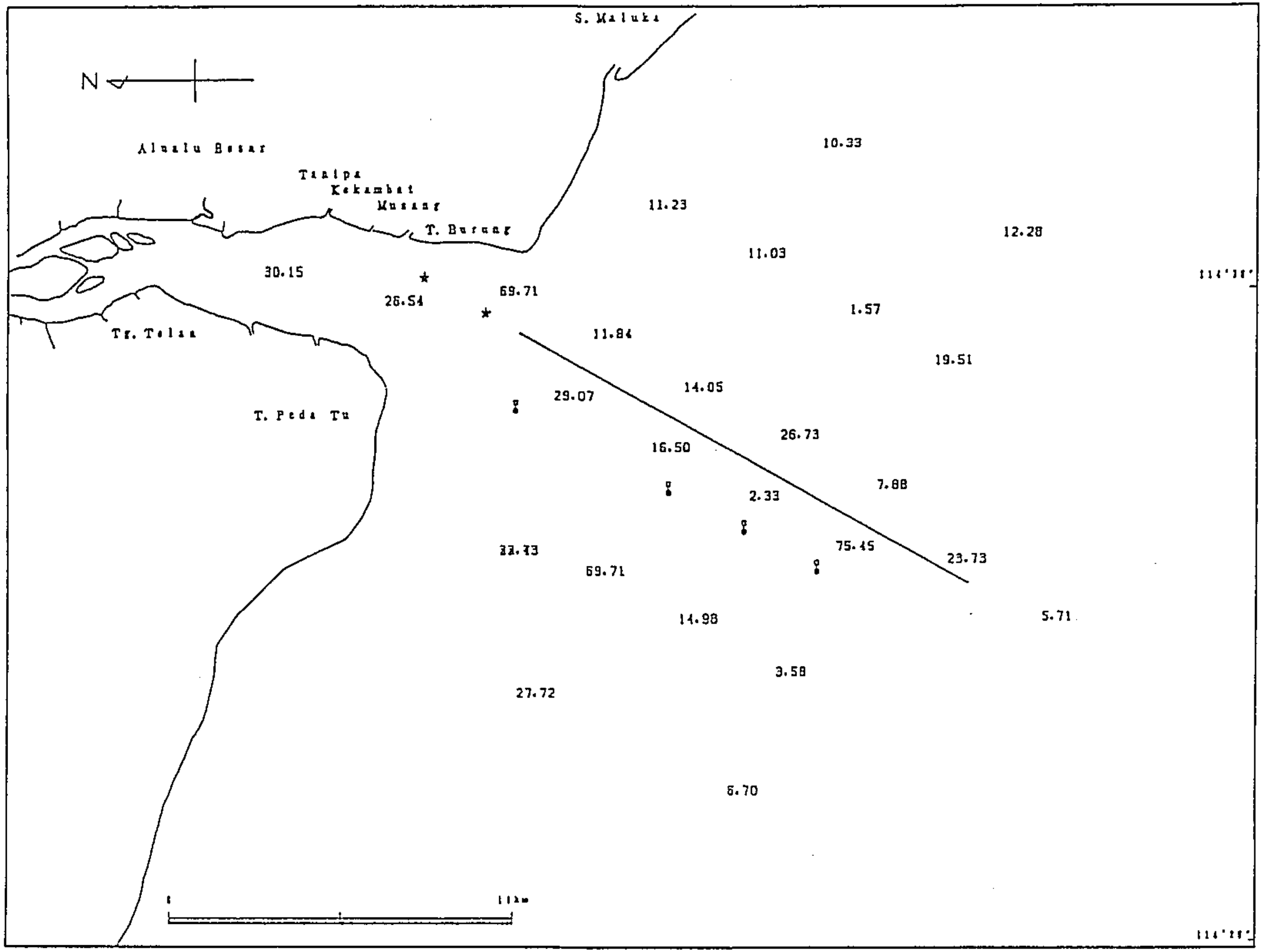


Fig. 5.3.5 −12 (3) Horizontal Distribution of SS
(2nd General Survey)

Survey Date : 21th Feb. 1989
Layer : 0.5m Above Seabed
Unit : SS (mg/ℓ)

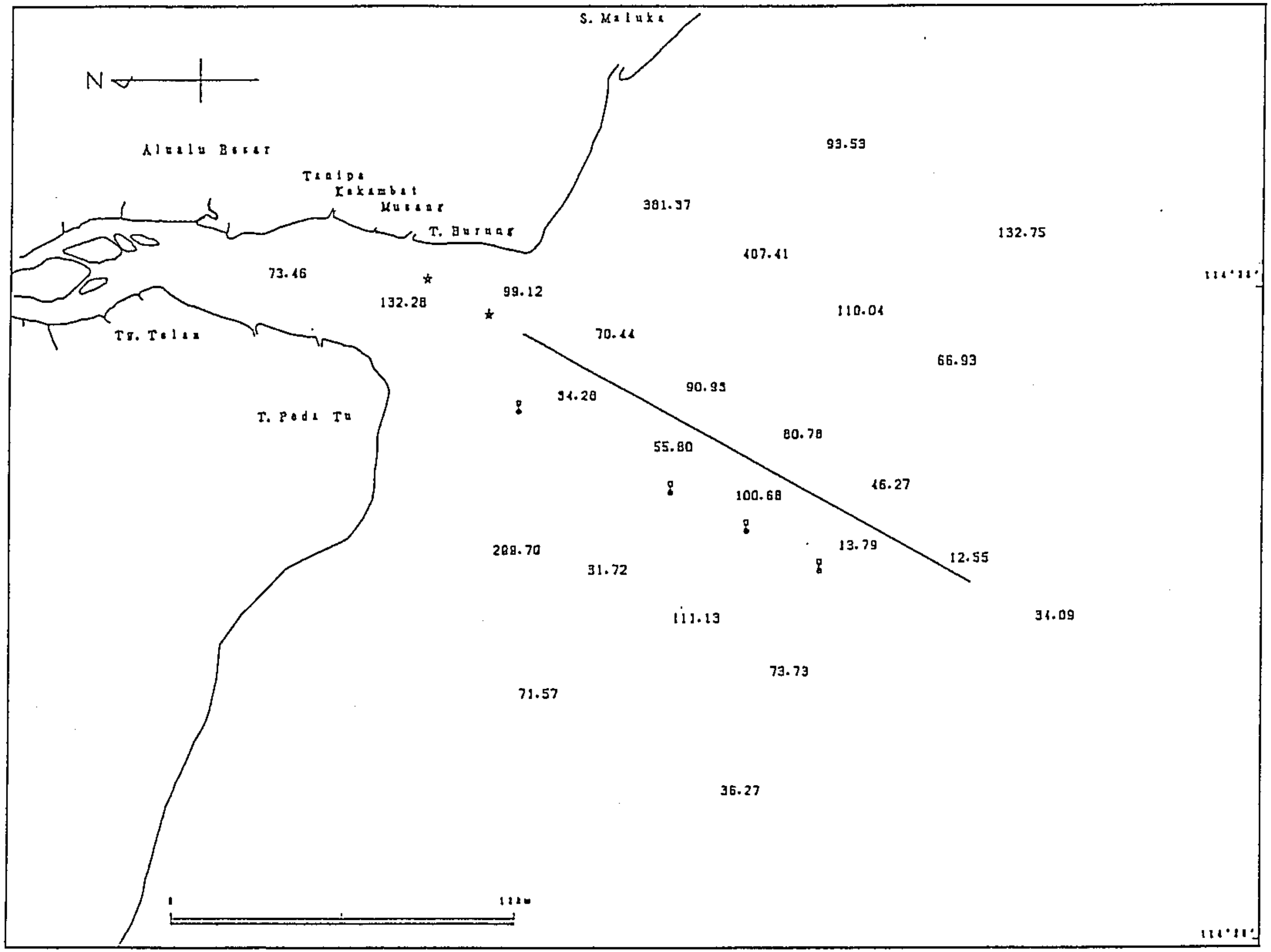


Fig. 5.3.5 −12 (4)   Horizontal Distribution of SS
(2nd General Survey)

5.4 Others

5.4.1 Echo-Sounding in Wide Area

The sounding area is spread about 40km from east to west and about 30km from north to south. A survey line interval is about 500 m and direction of survey line is the north to south with nearly a right angle to the coast line.
Positioning for survey ship was made by the Range/Range System using a microwave positioning system which determined a position by simultaneously measuring two distances from two known points on shore to the survey ship.
Records obtained by the echo-sounding were corrected by a result of tidal observation.After then bathymetric charts and contour charts were drawn on a scale of 1 to 50,000.
The coast line was determined on reference to the existing land maps and marine charts.
The echo-soundings in two times were conducted for the following periods.

1st stage: 19th Dec.1988 - 15th June 1989

2nd stage: 18th June - 1st Sep. 1989

And following profiles were made with survey line interval 2.5 km in the Access Channel area and 5 km in other area (Refer to Data file).

Longitudinal(N-S) Profile : Line 1 - 10

Cross (E-W) Profile : Line A - H

Profiles in the Access Channel and main part of shallow sea area only adopted in this report as shown in Fig.5.4.1-3 to Fig.5.4.1-5.

Examining a submarine topography in the wide area, a flat plane with water depth 1-2m distributes dominantly in the shape of semi-circle with a radius of about 15km centering the estuary. The access channel with water depth 5-6m extends to the estuary area crossing the middle part of the flat plane.
A dried up area develops in fron of the west coast and extends about 3-4km toward the offshore.
Other narrow and long elliptical shaped dried up area distributes with distance 5km from south to north and 2km from east to west.
South-east end of the dried up area contacts with the access channel.

In the east side coast, some dried up areas distribute centering T.Burung from the estuary along the coast. An area with water depth 3-10m continues toward offshore has an extremely gentle slope with a gradient 5/1000 at the access channel in the offshore and 1.5/1000 on the eastward slope area.

The middle part in the access channel with water depth 10-20m is a gentle slope topography area where assume a top of the valley topography approaching from southern outside of the area. Comparing with the 1st and 2nd general survey about submarine topography, the topography is almost similar without remarkable change except some changed places in the flat plane area with water depth 2m.
It means that a developing dried up area in front of the west coast and elliptical shaped area contacting with westside of the access channel are also similar to the distributed areas. This conditions are well expressed by Fig.5.4.1-4.

The conditions changed on the flat plane with water depth 2m are as follows:

- A middle part area on the eastside of the access channel was changed a little in the 1 m contour line and the small dried up area which had been seen in the 1st stage were disappeared in the 2nd stage.

- A dried up area in the eastern part of the estuary and the 1m contour line has been partly changed a little and it can be seen that the 1m contour line has advanced in 200-300m.

The followings are summarized about the changed conditions for the flat plane area with water depth 2m.
It seems that small changed but no big scale conditions exsists in many area with the 1 m contour line on the east side of the access channel and the dried up area in distributions.

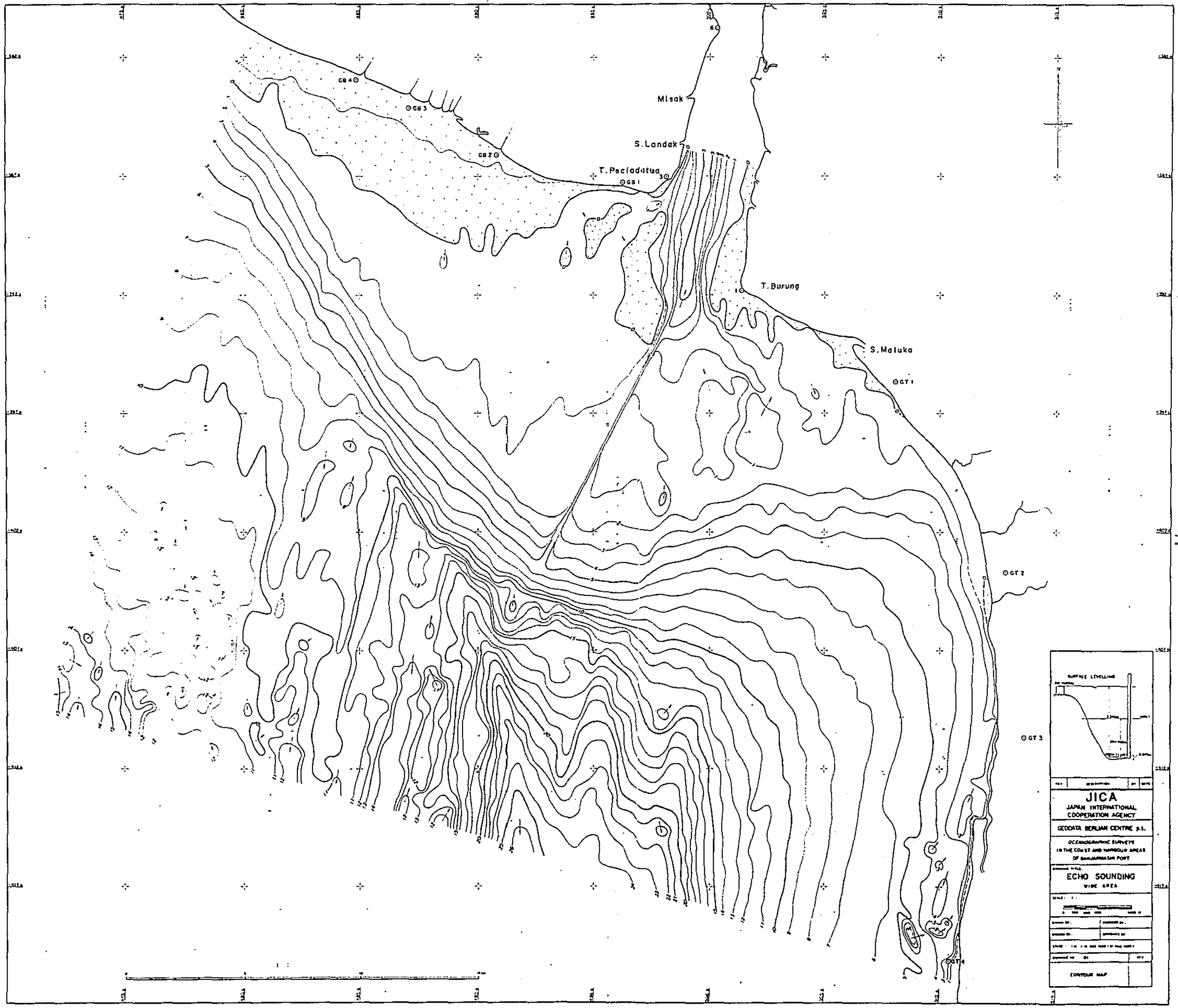


Fig.5.4.1-1 CONTOUR MAP (1st Stage)

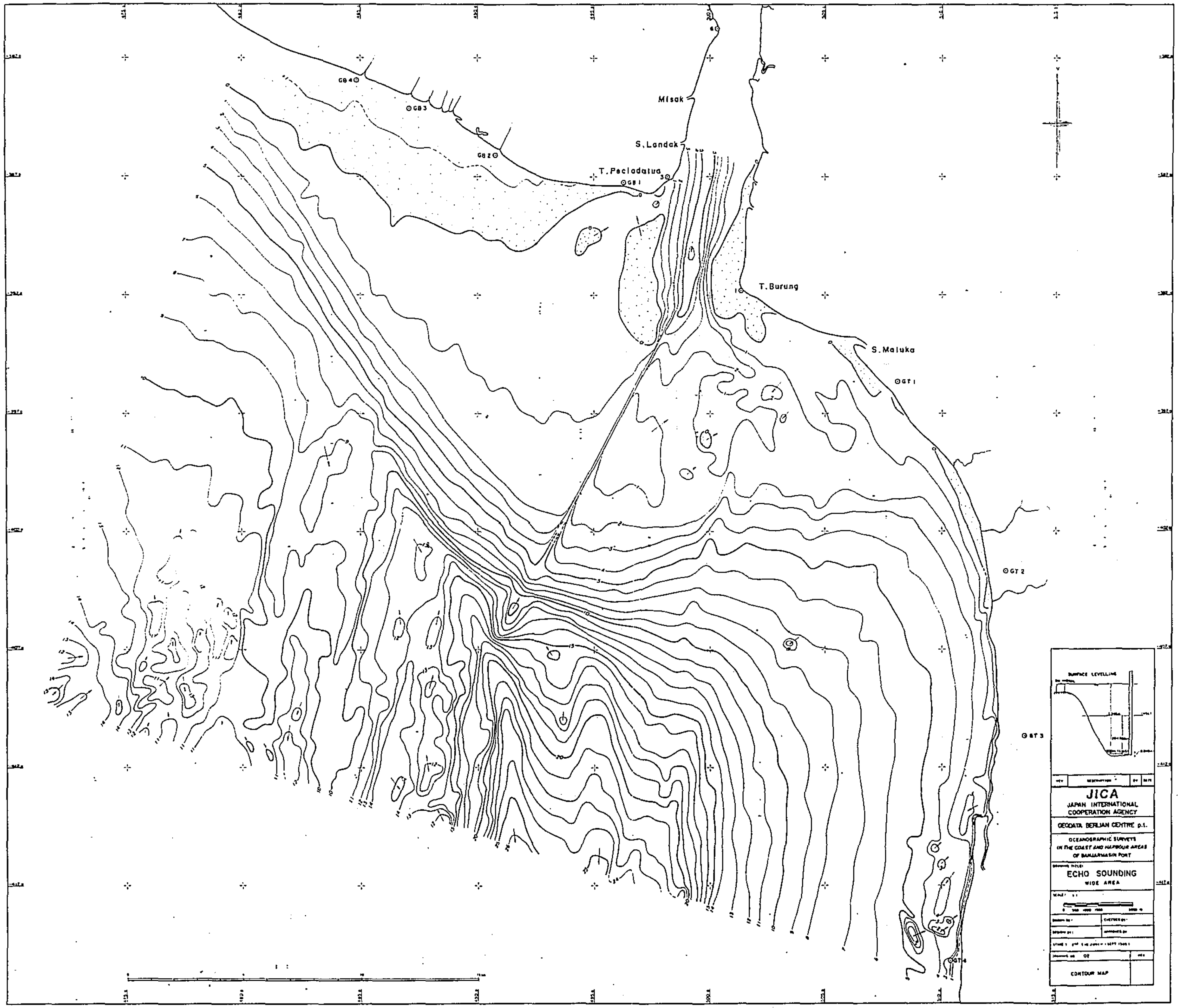


Fig.5.4.1-2 CONTOUR MAP (2nd Stage)

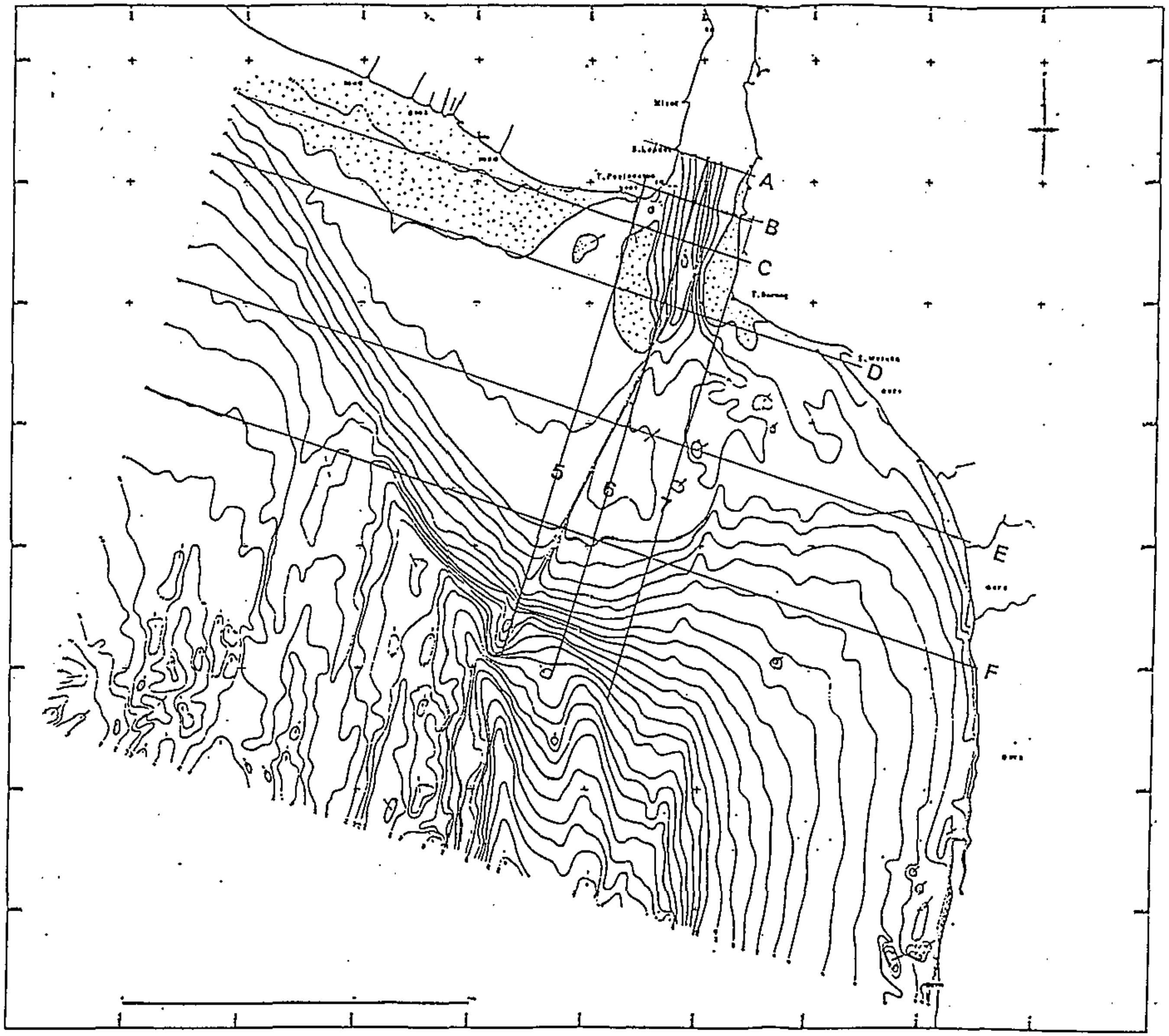


Fig. 5.4.1-3 Survey Lines for Longitudinal (N-S) and Cross (E-W) Profile

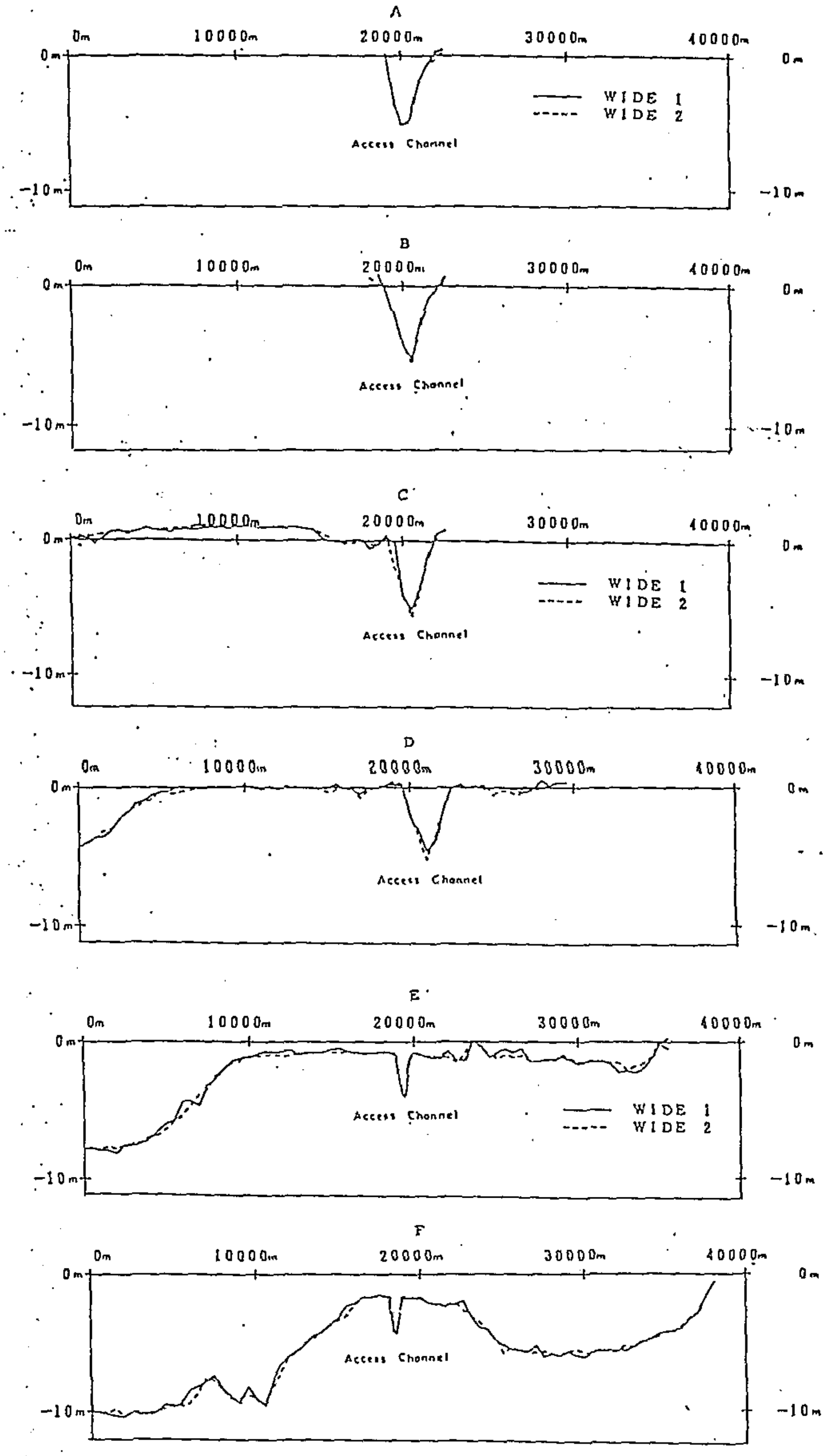
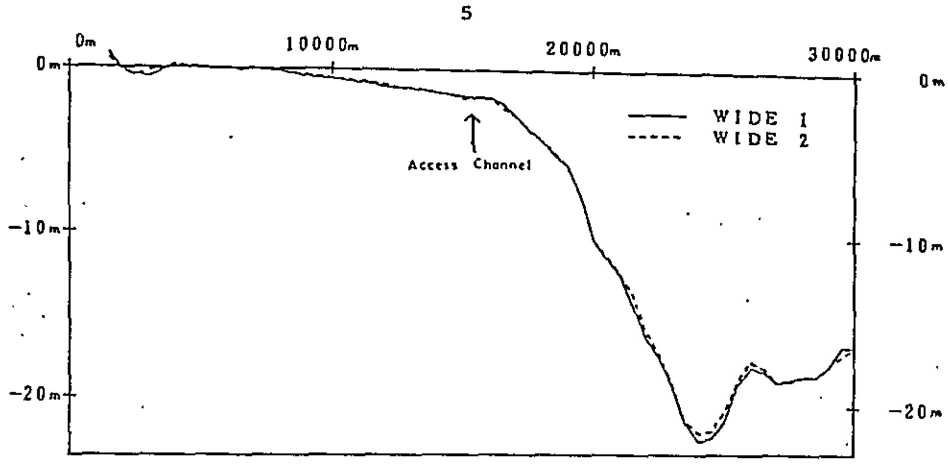
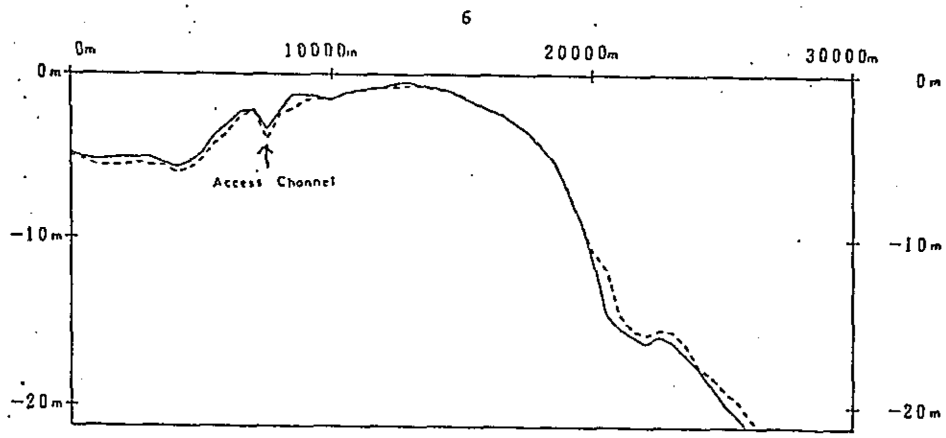


Fig. 5.4.1-4 Cross (E-W) Profile





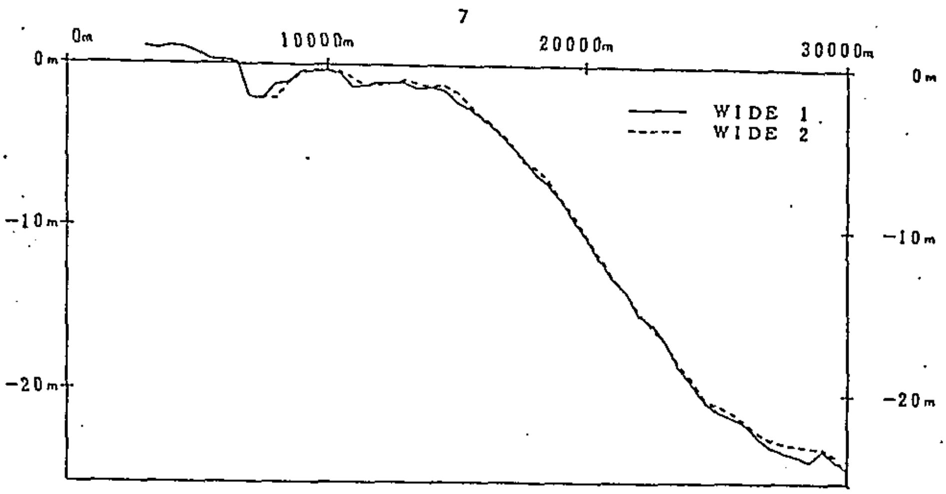


Fig. 5.4.1-5 Longitudinal (N-S) Profile

5.4.2 Soil Boring

Soil boring were performed in the period of June to August 1989.

The work consists of :

- Theree (3) boreholes to a depth of 20 m each.
- Sampling :Undisturbed samples and standard split spoon samples were taken in each borehole, depending on the prevailing ground conditions.
- In Situ Testing :Standard Penetration Test were carried out at each 2 m interval.
  Handy type Vane Shear Test were carried out at the upper end of undisturbed samples.

1)In Situ Test

-Standard Penetration Tests

The Standard Penetration Tests(SPT) were carried out at different depths during the course of drilling. The standard split spoon sampler was driven with the blows from 63.5kgf, hammer falling through 75cm for a distance of 30cm.
The number of blows required to effect 30cm penetration was recorded as standard penetration resistance,N.
The N value observed are shown in the bore hole logs.

-Vane Shear Tests

A vane shear test was carried out at the upper end of undisturbed samples in the cohesive soil.
The test was carried out using a handy type Vane Shear apparatus with Torque driver of 0-10 kg cm capacity(No.10 FTD).

-Liquid Limit and Plastic Limit

The test were performed on fine grained soil for classification purpose. The test were done according to JIS A 1205 and JIS A 1206.

-Grain Size Analyses

The grainsize analyses were performed to evaluate the grainsize distribution and percentage of coarse and fine grained fraction of soil. The tests were carried out according to JIS A 1204.

-*Unconfined Compression Test*

The Unconfined Compression Test samples were available in 1.5 inches diameter by 3 inches length. The tests were carried out according to ASTM D-2166.

-Consolidation Tests
Consolidation tests were carried out in 60 mm diameter x 20 mm height and a 2.42 inches diameter x 1 inch height samples. Tests were done using consolidation pressures of 0.05, 0.1, 0.2, 0.4, 0.8, 1.6, 3.2, and 6.4 kg/cm2.
The tests were done as per ASTM D-2453. The results are presented as e-log p and cv-log p curves and are included in Fig.5.4-2(6)-(8).

2) Laboratory Testing

In general, the laboratory testing was carried out on the thin wall samples. A small amount of classification testing was also carried out on the SPT split spoon samples and on selected core samples.

Laboratory testing were carried out for the purpose of evaluating the physical characteristic and engineering properties.

The tests carried out in the laboratory are :

- Natural Water Content and Volumetric Weight

- Specific Gravity

- Liquid Limit and Plastic Limit

- Grainsize Analyses

- *Unconfined Compression Test*

- Consolidation Tests

Natural water content

The tests were carried out soon after the undisturbed samples extruded. These tests were performed according to the JIS A 1203.

Determination of Specific Gravity

The tests were performed according to the JIS A 1202.

3) Summary of Soil Profile

The generalized subsurface soil statigraphy in the area of soil boring work is as follows :

- The site is mantled with dark gray loose fine sand with gravelsize organic fragments. The thickness of this layer varies from 2.7 to 4 meters in the boreholes location.

- The fine sand layer is underlain by very soft to soft silt and clay to silty clay (CH) trace sand up to the end of borehole. The sand portion becomes less and less with the increasing of depth.

- The N values vary from 0 - 4 blow/ft. In the borehole B2, the N values of 5 - 6 are found at about -19 m LWS.

- Handy type vane shear tests were carried out at the upper end of undisturbed samples on cohesive soils give the value of undrained shear strength vary from 0.11 - 0.24 kg/cm2.

- The unconfined compression tests were carried out on cohesive soil given the results of qu vary from 0.11 to 0.51 kg/cm2.

- To know exactly the stiff-hard soil layers, deeper bore holes should be performed in the detailed design stage.

Reference should be made to the individual borehole logs and test result for a detailed description of the soils encountered in each borehole.

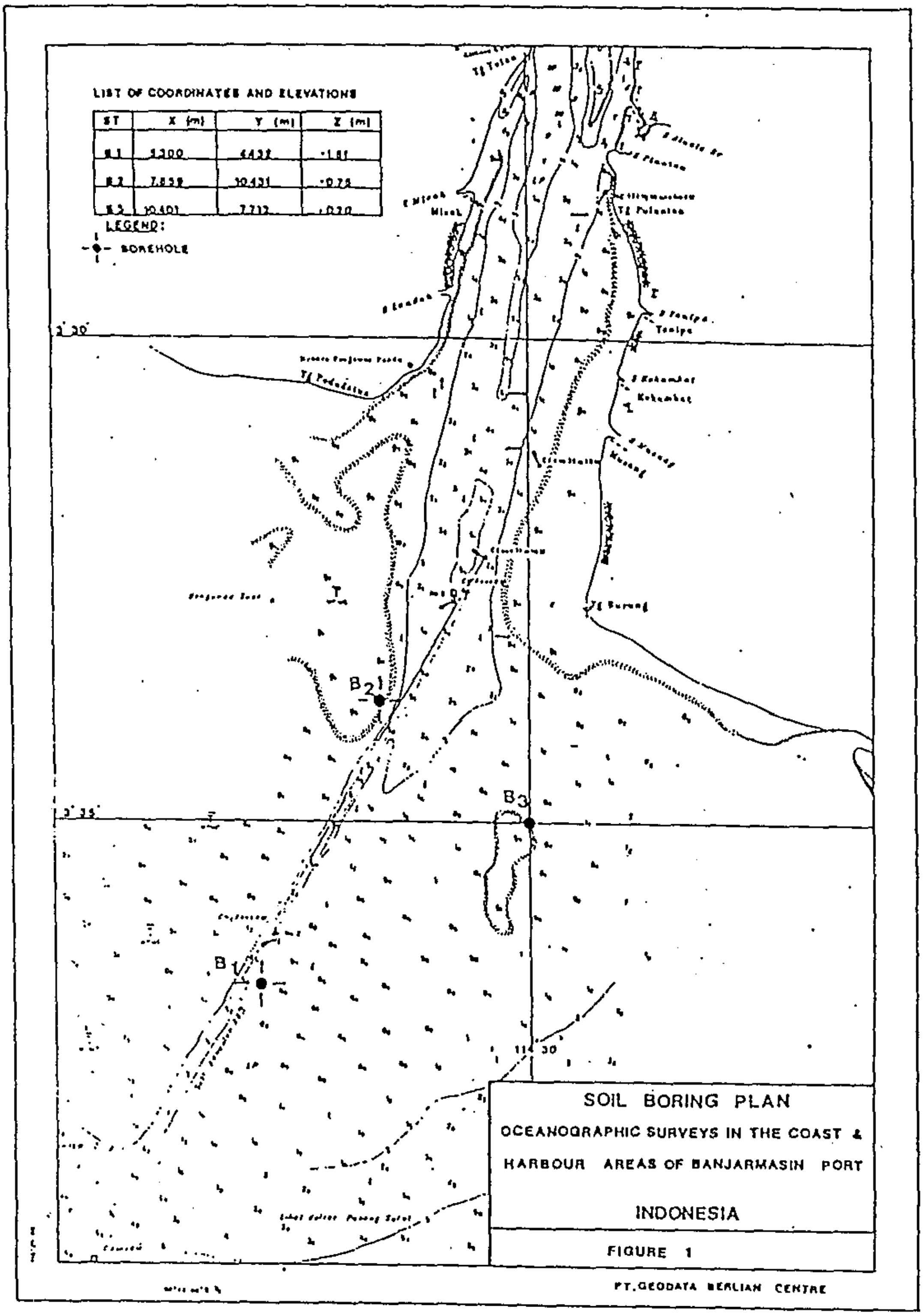


Fig. 5.4-2(1) Planned Soil Boring Stations

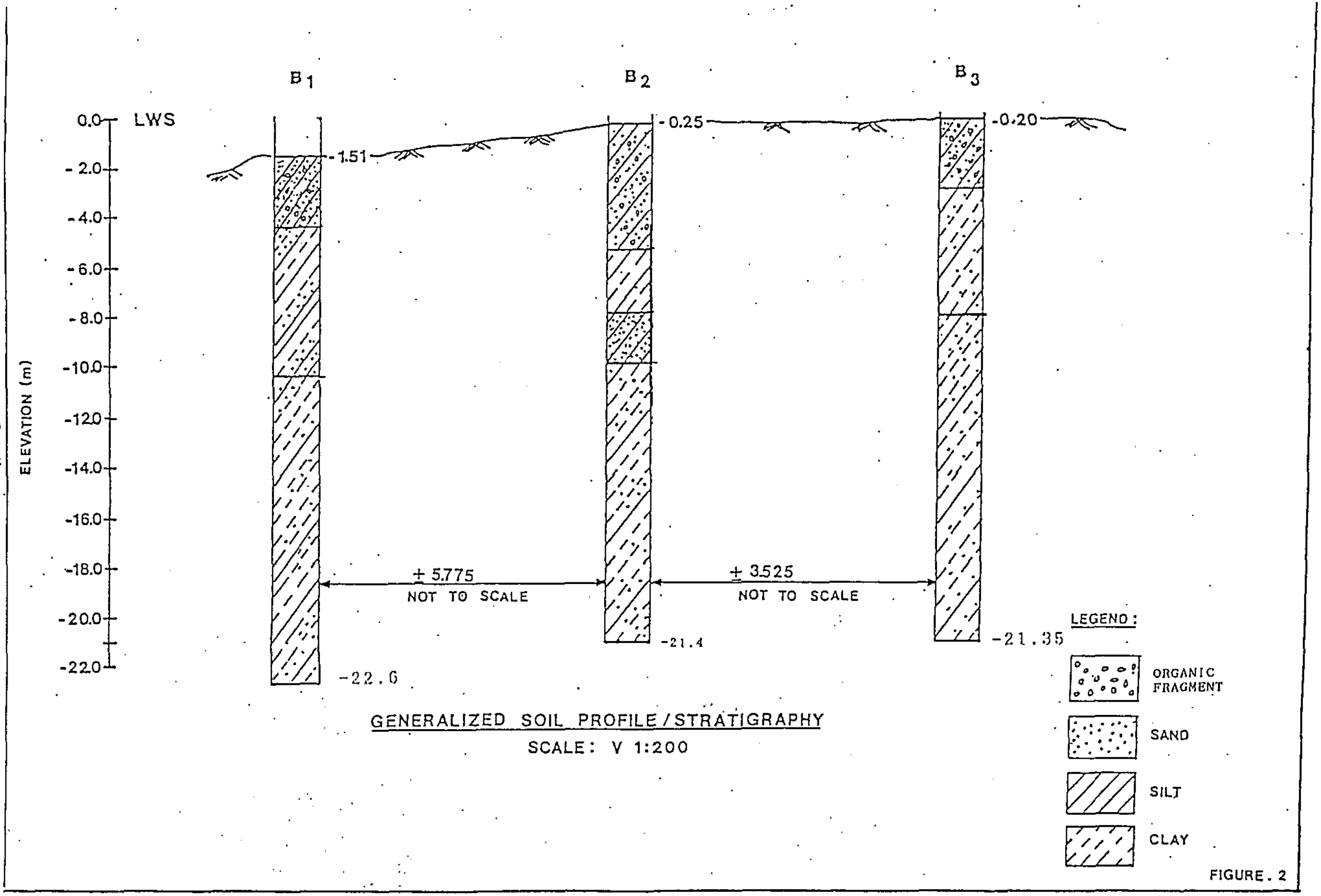


Fig. 5.4-2(2) Profile of Soil Boring

Explanatory Notes for Borehole Logs

Description of Soils

Identification of soil layers is based on visual examination of boring samples and laboratory classification tests. Terminology used to describe soils is based on the following terms :

Classification	Size of Particles
Clay	Less than 0.005 mm
Silt	From 0.005 to 0.074 mm
Sand	From 0.074 to 2 mm
Gravel	From 2.00 to 75 mm
Cobbles	From 75 to 200 mm
Boulders	Larger than 200 mm

Terminology	Proportion
Trace	Less than 10 %
Some	10 to 20 %
Adjective (eg. sandy or silty)	20 to 35 %
And (eg. sand and gravel)	35 to 50 %

Field Tests

Standard penetration resistance "N" number of blows required to drive the last 30 cm of the standard sampler (split spoon SS) of 51 mm diameter, by means of a hammer of a weight 63,5 kg which is allowed to drop fully for 75 cm high.

BOREHOLE LOG

PROJECT: SOIL BORING WORK
LOCATION: BANJARMASIN
COORDINATS: X = 5300 m ; Y = 4432 m
WATER LEVEL DEPTH
DRILLING DATE: 15 - 17 JULY 1989
ACCOMPANYING DUTCH CONE PENETRATION TEST(S):

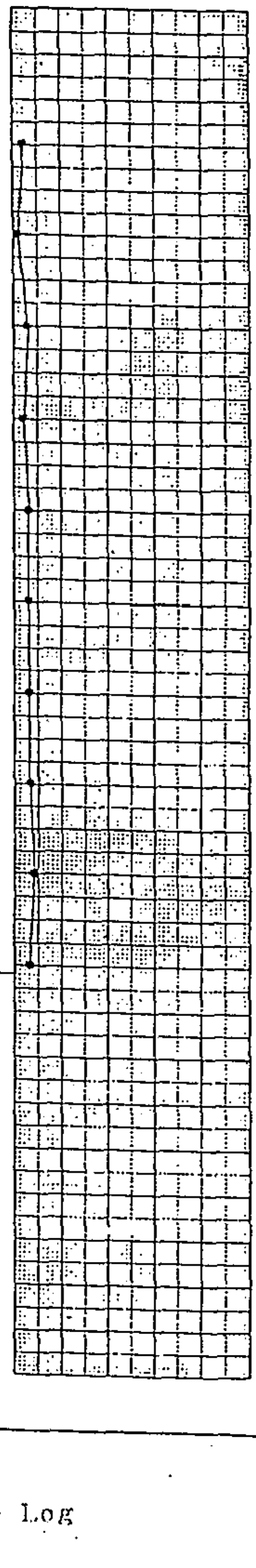
ELEVATION: - 1,51 m
DRILLING RIG: YBM
NO. ______ NO. ______

BOREHOLE NO.: B1
SHEET: 1 OF 1
DATUM: LWS
ENGINEERS: ______
Distance. From BH. ______ (m)
Distance. From BH. ______ (m)

DATE	CASING	WATER LEVEL	THICKNESS (M)	DEPTH (M) From	DEPTH (M) To	RECOVERY (%)	DESCRIPTION	ELEVATION DEPTH (M)	N Value
							Sea Bed	0	
15 - 07 - 1989	16.00 m		2.70	2.00	2.70	0	Dark grey silty fine SAND with gravelsize organic fragment (ø 0,1 - 0,5 cm), loose.		
				2.85	3.15	100	Sandy clayey SILT to SILT and CLAY trace sand. Colour : dark grey, very soft to soft consistency.		2
			6.00	4.00	4.70	0			
				4.85	5.15	100		-5	1
				6.00	6.70	0			
				6.85	7.15	100			3
				8.00	8.70	0			
16 - 07 - 1989				8.85	9.15	100	Silty CLAY trace sand, grey, very soft to soft consistency.		2
				10.00	10.70	0		-10	
				10.85	11.15	100			3
				12.00	12.70	78			
				12.85	13.15	100			3
			>12.00	14.00	14.70	76			
				14.85	15.15	100	Becoming SILT and CLAY	-15	3
17 - 07 - 1989				16.00	16.70	94	Silty CLAY trace sand.		
				16.85	17.15	100			3
				18.00	18.70	64			
				18.85	19.15	100			4
				20.00	20.70	65		-20	
				20.85	21.15	100	end of borehole		3
								-25	
								-30	

INSITU TESTING

0 - 0.5 - 1 - 1.5 - 2 - 2.5
0 - 1 - 2 - 3 - 4 - 5
0 - 10 - 20 - 30 - 40 - 50



REMARKS:

- SPT N - blows/30cm
- POCKET Penetrometer qu - Kg/Cm²
- HAND TORVANE Cu - Kg/Cm²
- VANE SHEAR (V) Su - Kg/Cm²
- UNDISTURBED SAMPLE (U)
- SPT (S)

NOTE

Fig. 5.4-2(3) Borehole Log

BOREHOLE LOG

PROJECT: SOIL BORING WORK -
LOCATION: BANJARMASIN
COORDINATS: X = 7859 m ; Y = 10431 m
WATER LEVEL DEPTH:
DRILLING DATE: 5 - 7 JULY 1989
ACCOMPANYING DUTCH CONE PENETRATION TEST(S):

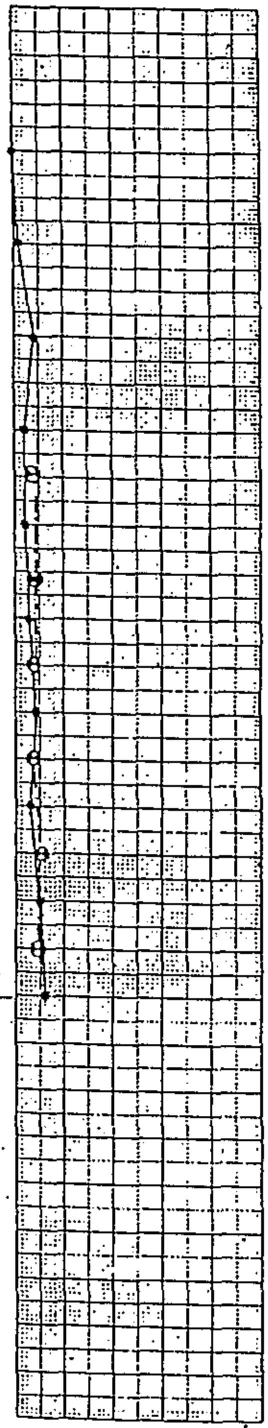
ELEVATION: - 0,25 m
DRILLING RIG: YBM
NO.
NO.

BOREHOLE NO: B2
SHEET 1 OF :
DATUM: LWS
ENGINEERS:
Distance. From BH: (m)
Distance. From BH: (m)

DATE	CASING	WATER LEVEL	THICKNESS (M)	DEPTH (M) From	DEPTH (M) To	TYPE OF BORING OR SAMPLING	RECOVERY (%)	DESCRIPTION	N Values
		▽						Sea Bed	
5-07-1989	10.00 m		4.70	2.00	2.70		0	Dark grey silty fine SAND with gravelsize organic fragment (Ø0,2 - 0,8 cm), loose.	
				2.85	3.15	SPT	100		0
				4.00	4.70		0		
			2.50	4.85	5.15	SPT	100	SILT and CLAY to silty CLAY trace sand. Colour : dark grey, Consistency very soft to soft	1
				6.00	6.70	U	80		
				6.85	7.15	SPT	100		4
			2.00	8.00	8.70		0	Silty fine SAND TRACE clay loose.	
6-07-1989			>12.00	8.85	9.15	SPT	100	Dark grey silty CLAY trace sand very soft to soft consistency.	2
				10.00	10.70	U	80		
				10.85	11.15	SPT	100		2
				12.00	12.70	U	60	Becoming SILT and CLAY	
				12.85	13.15	SPT	100		3
				14.00	14.70	U	86		
				14.85	15.15	SPT	100	Dark grey silty CLAY trace sand, soft	4
7-07-1989				16.00	16.70	U	85		
				16.85	17.15	SPT	100		3
				18.00	18.70	U	78		
				18.85	19.15	SPT	100		5
				20.00	20.70	U	63		
				20.85	21.15	SPT	100	end of borehole	6

ELEVATION DEPTH (M): 0, 5, 10, 15, 20, 25, 30

INSITU TESTING



REMARKS

- SPT N-blows/30cm
- POCKET Penetrometer Su-Kg/Cm²
- HAND TORVANE Cu-Kg/Cm²
- VANE SHEAR (V) Su-Kg/Cm²
- UNDISTURBED SAMPLE (U)
- SPT (S)

NOTE

Fig. 5.4-2(4) Borehole Log

BOREHOLE LOG

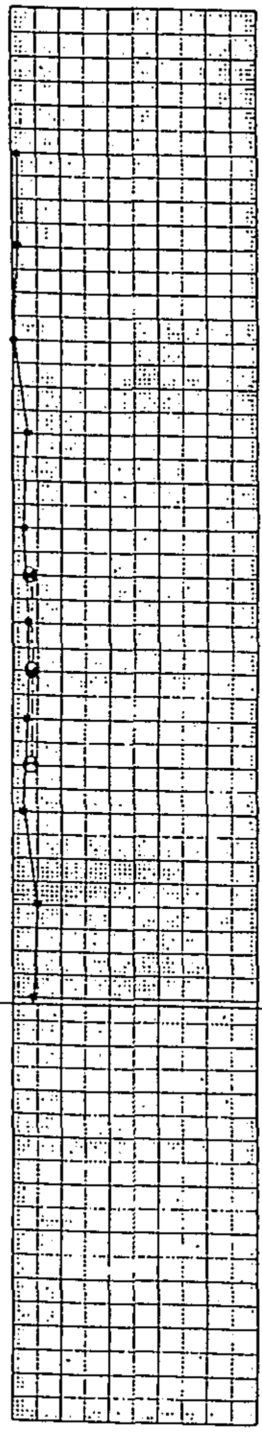
PROJECT: SOIL BORING WORK
LOCATION: BANJARMASIN
COORDINATS: X = 10401 m ; Y = 7712 m
WATER LEVEL DEPTH:
DRILLING DATE: 25 - 29 JULY 1989
ACCOMPANYING DUTCH CONE PENETRATION TEST(S):

ELEVATION: - 0,20 m
DRILLING RIG: YBM
NO.:
NO.:

BOREHOLE NO.: B1
SHEET 1 OF 1
DATUM: LWS
ENGINEERS:
Distance. From BH: (m)
Distance. From BH: (m)

DATE	CASING	WATER LEVEL	THICKNESS (M)	DEPTH (M) From	DEPTH (M) To	TYPE OF BORING OR SAMPLING	RECOVERY (%)	GRAPH	DESCRIPTION	ELEVATION DEPTH (M)	N Value
25-06-1989	16.00 m	▽							Sea Bed	0	
			2.50						Dark grey silty fine SAND with gravel size organic fragment (Ø 0,2 - 0,8 cm).		
				2.00	2.70	▯	0				
				2.85	3.15	SPT	100				1
			5.00	4.00	4.70	U	88		SILT and CLAY with some sand, consistency very soft. Colour : Grey		
				4.85	5.15	SPT	100			-5	1
26-06-1989				6.00	6.70	▯	0				
				6.85	7.15	SPT	100				0
			12.00	8.00	8.70	U	88		Dark grey silty CLAY trace sand very soft to soft consistency.		
				8.85	9.15	SPT	100				3
				10.00	10.70	U	57			-10	
				10.85	11.15	SPT	100				2
27-06-1989				12.00	12.70	U	63				
				12.85	13.15	SPT	100				3
28-06-1989				14.00	14.70	U	84				
				14.85	15.15	SPT	100			-15	3
				16.00	16.70	U	78,5				
				16.85	17.15	SPT	100				2
29-06-1989				18.00	18.70	▯	89				
				18.85	19.15	SPT	100				5
				20.00	20.70	▯	87			-20	
				20.85	21.15	SPT	100		end of borehole		4

INSITU TESTING
0---0.5---1---1.5---2---2.5
0---1---2---3---4---5
0—10—20—30—40—50



REMARKS
- SPT N-blows/30cm
- POCKET Penetrometer Su-Kg/Cm²
- HAND TORVANE Cu-Kg/Cm²
- VANE SHEAR (V) Su-Kg/Cm²
- UNDISTURBED SAMPLE (U)
- SPT (S)

NOTE

Fig. 5.4-2(5) Borehole Log

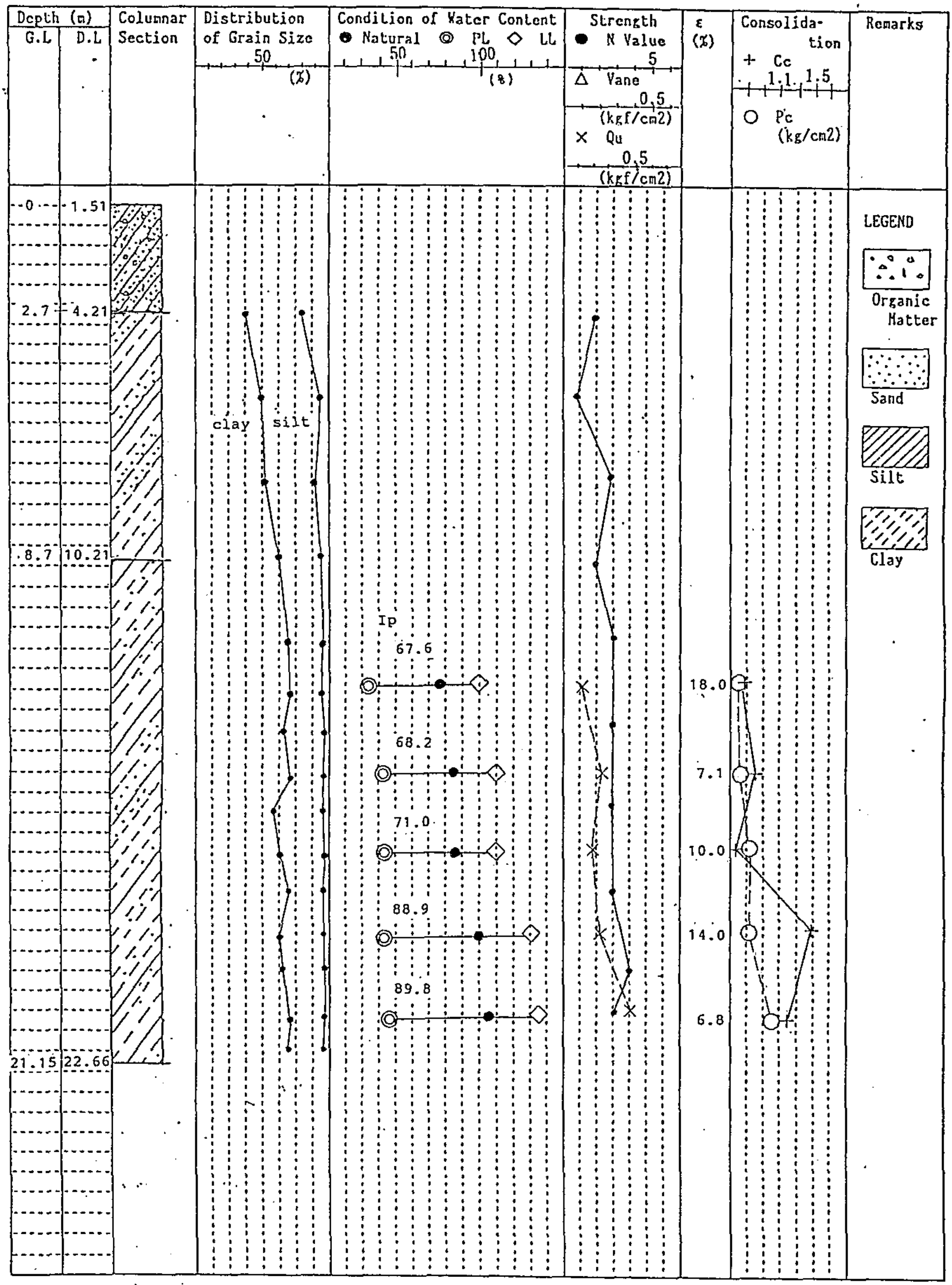


Fig. 5.4-2(6) SUMMARY OF SOIL TEST FOR SOIL BORING (BOREHOLE NO. B1)

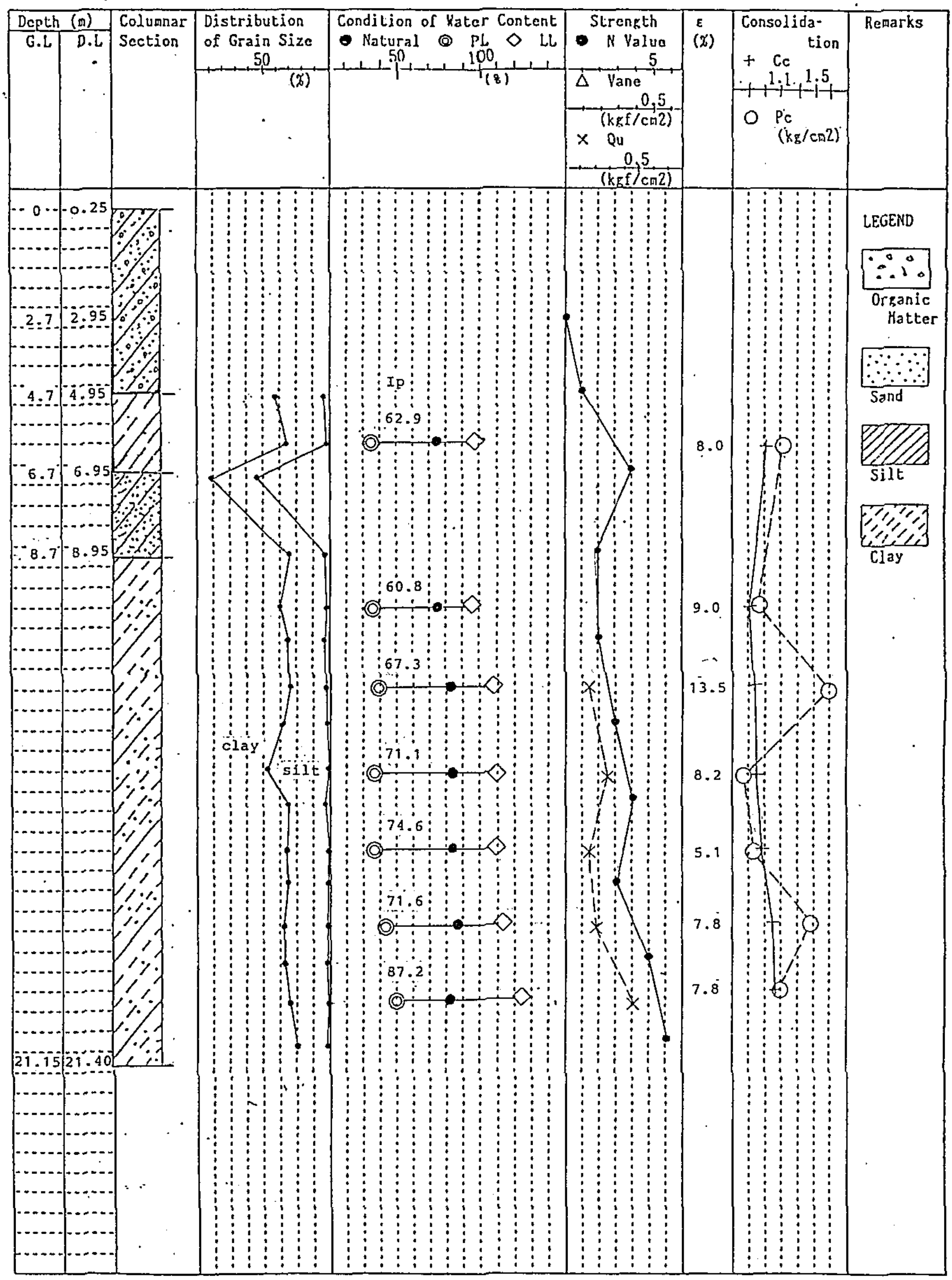


Fig. 5.4-2(7) SUMMARY OF SOIL TEST FOR SOIL BORING (BOREHOLE NO.B2)

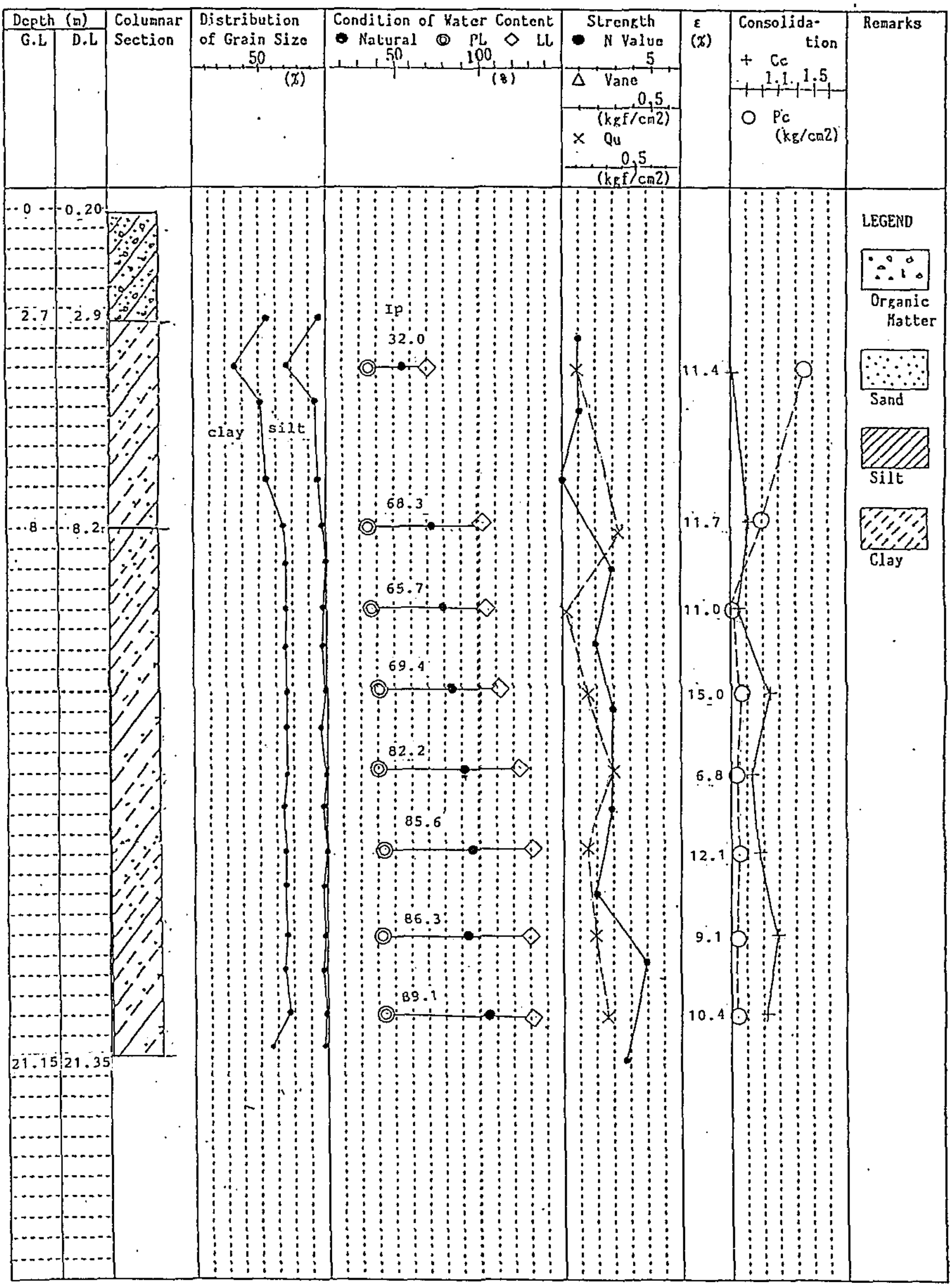


Fig. 5.4-2(8) SUMMARY OF SOIL TEST FOR SOIL BORING (BOREHOLE NO. B3)

5.4.3 Seabed Level

Seabed Level Survey I and II were conducted at 10 stations with different water depths in and out side of the Access Channel on the undermentioned dates and durations.

Seabed Level Survey I : on 13th and 14th May 1989

Seabed Level Survey II: on 1st and 2nd June 1989

Folowing the surveys were made:

* Comparison of water depths at each station among records by 210kHz,33kHz and a sounding lead.

* Various vertical distributions for water temperature, salinity, turbidity and current velocity.

* Core sample analysis by depths for water content and bulk density.

Both reflected surfaces by 210kHz and 33kHz not appeared in separation from 1st stage to 4th stage of Echo-sounding in Narrow Area but both surfaces appeared partly in separation at some small area around middle part of the Access Channel in the 5th stage.
In the 6th stage, both separated surfaces appeared widely in the spreading distribution around northern or southern part area of the Access Channel.
In the 7th stage, both separated surfaces appeared in whole area except north end of the Access Channel.

1) Seabed Level Survey I was conducted just after the 7th stage of Echo Sounding in Narrow Area.

Results are as follows:

(1) Layer thickness of muddy water was 4m at maximum.

(2) The sampled water was muddy water without cohesive(Test on a tongue was salty taste.).

(3) On the visual check for core sample, it was unknown whether consolidation carried out or not in the sample.

(4) Much muddy water was not seen outside of the Access Channel but light brown colored fluid mud accumlated with about 20cm thickness.

(5) When the survey was conducting on 14th May 1989, some Siome(junction lines between water mass) existed adjacent to Spot 6000(Co.320).
In the sea area offshore over the Siome, transparency was comparatively good condition with Secchi disk depth 2- 3m.

(6) Following conditions were found on the muddy water according to various measurement results by using observational equipment.

* When a sensor of salinometer went down muddy water, the value decreased greatly(several ten ‰).

* When a sensor of turbid meter went down muddy water, it's value showed "0" . However, the value varied in wide range on a boader surface between muddy water and fluid mud due to contacting with mud on the seabed (several ten to several hundreds ppm).

* When currentmeter(EMC-107) went down muddy water,the velocity became ten times and varied violently and never settled at "0". The directions showed unstable.

(7) Observed data at Spot 4300(St.J) was shown in Fig.5.4- 3(4) as typical results.

2) Seabed Level Survey II was conducted on 1st and 2nd June 1989. A condition of muddy water in this time survey(This means intermediate layer between both reflected surfaces by 210kHz and 33kHz) changed obviously in comparison with visual observation for core sample of Seabed Level Suvey I because agitation dredging had started in the Access Channel from 29th May 1989.
Following differences between this time and previous time were found.

(1) Muddy water at 5 stations in the Access Channel was more thin without cohesive.

(2) Muddy water showed rather dark brown and mixed with black colored fine tips of organic materials in excess.

(3) Muddy water was sampled on a hand and visual test was carried out and following were found.

* Muddy water on previous time survey(Seabed Level Survey I) was light brown color with comparative cohesive and homonized fine particle.
On the contrary, muddy water in this time was dark brown color without cohesive with rough particle of tips of organic materials.

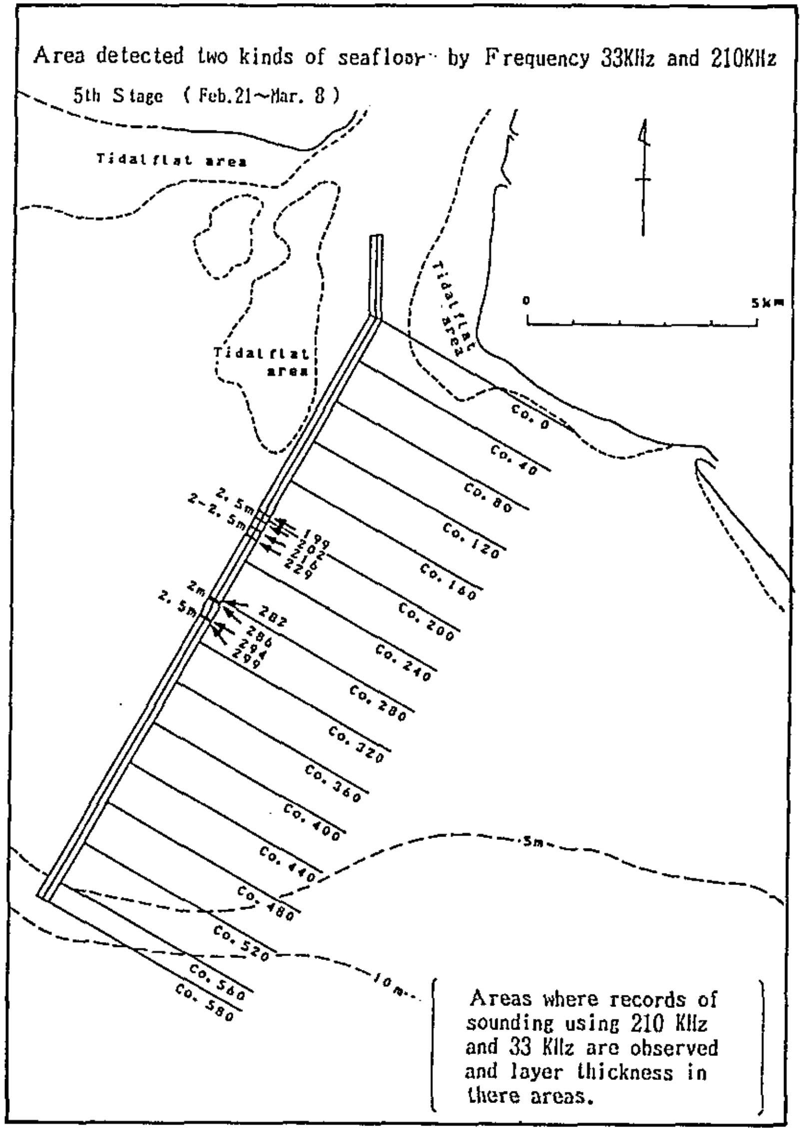
(4) The reflected surface by 210kHz was apt to be suffer from under going vessel and changed or disappeared.
These conditions were recorded by echo sounding(cf.Record at St.121 and 341).

(5) According to results by measurement of muddy water using observational equipment,tendency of characteristic of muddy water was almost similar compared with it on previous time survey.

* When sensor of salinometer went down muddy water,value of salinometer decreased greatly(several ten).
* When sensor of turbid meter went down muddy water value of it showed "0". However,the value on the reflected surface by 210kHz varied greatly due to contacting with muddy water.
* As for ccurrent, it seemed that velocity decreased but it value was not able to read with direction due to unstable condition.

(6) Observed data for St.121 and St.341 were shown in Fig.5.4-3(10) and 5.4-3(14) as typical results of the survey.

(7) Results of core sample taken by Seabed Level Survey I and II were shown in Table 5.4-3(2) and 5.4-3(4).



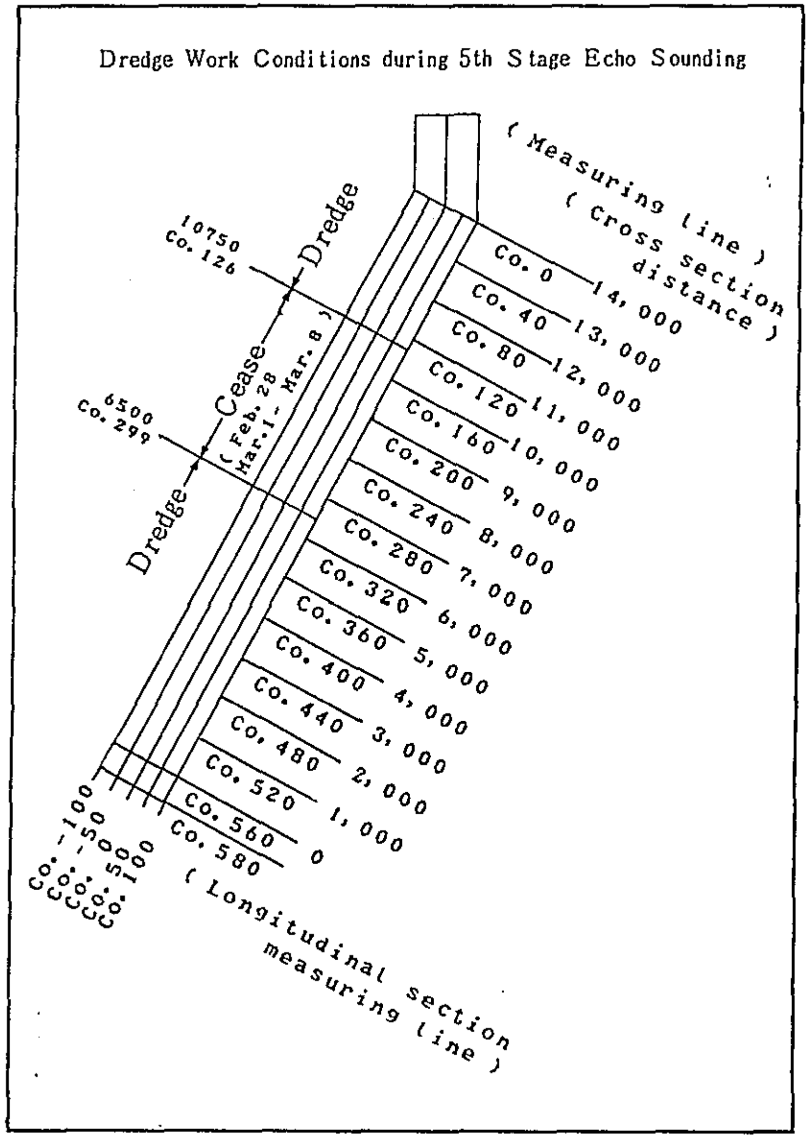
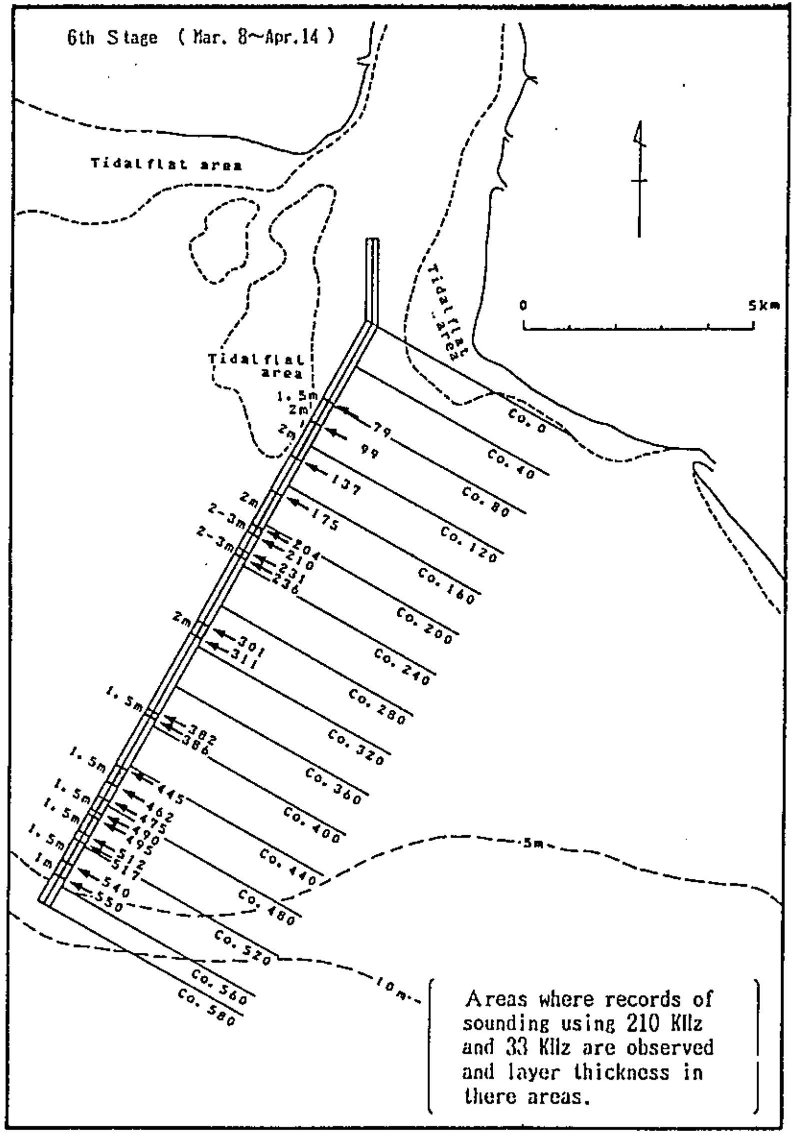


Fig. 5.4-3(1) Relation between Dredge Work and Result of 5th Stage Echo-Sounding in Narrow Area



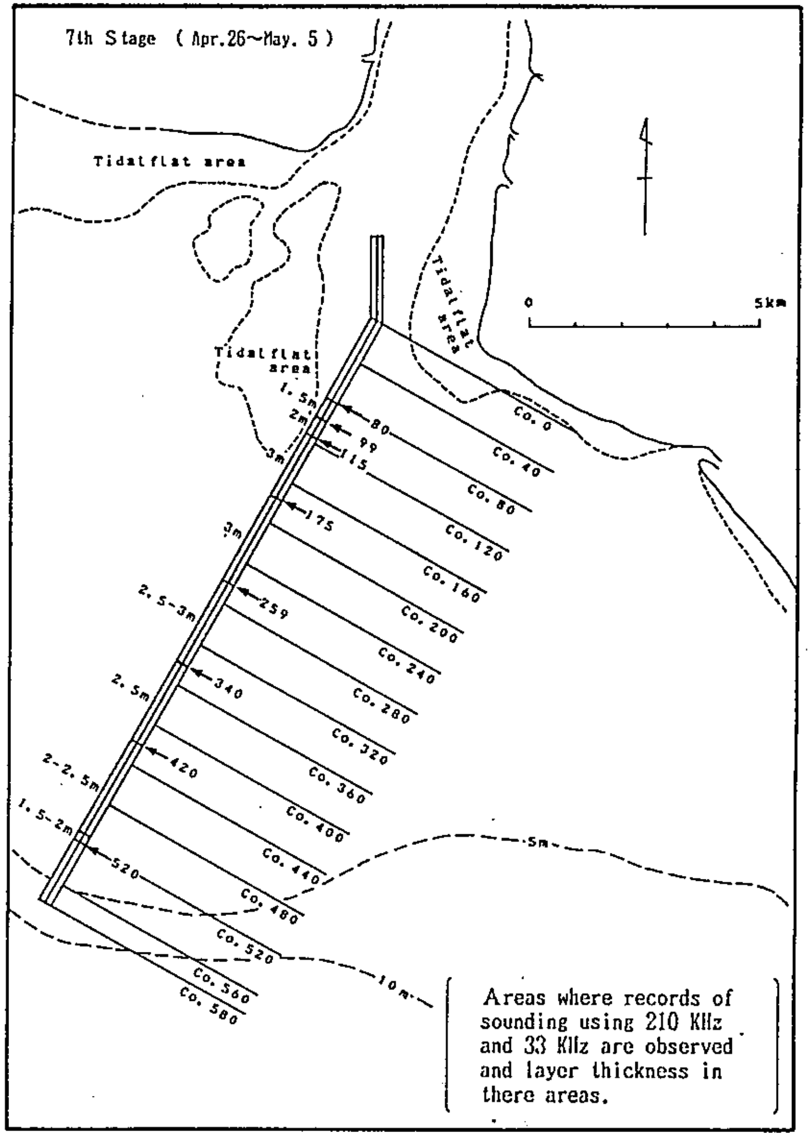


Fig. 5.4-3(2) Area Detected Two Kinds of Seabed by 33kHz and 210kHz

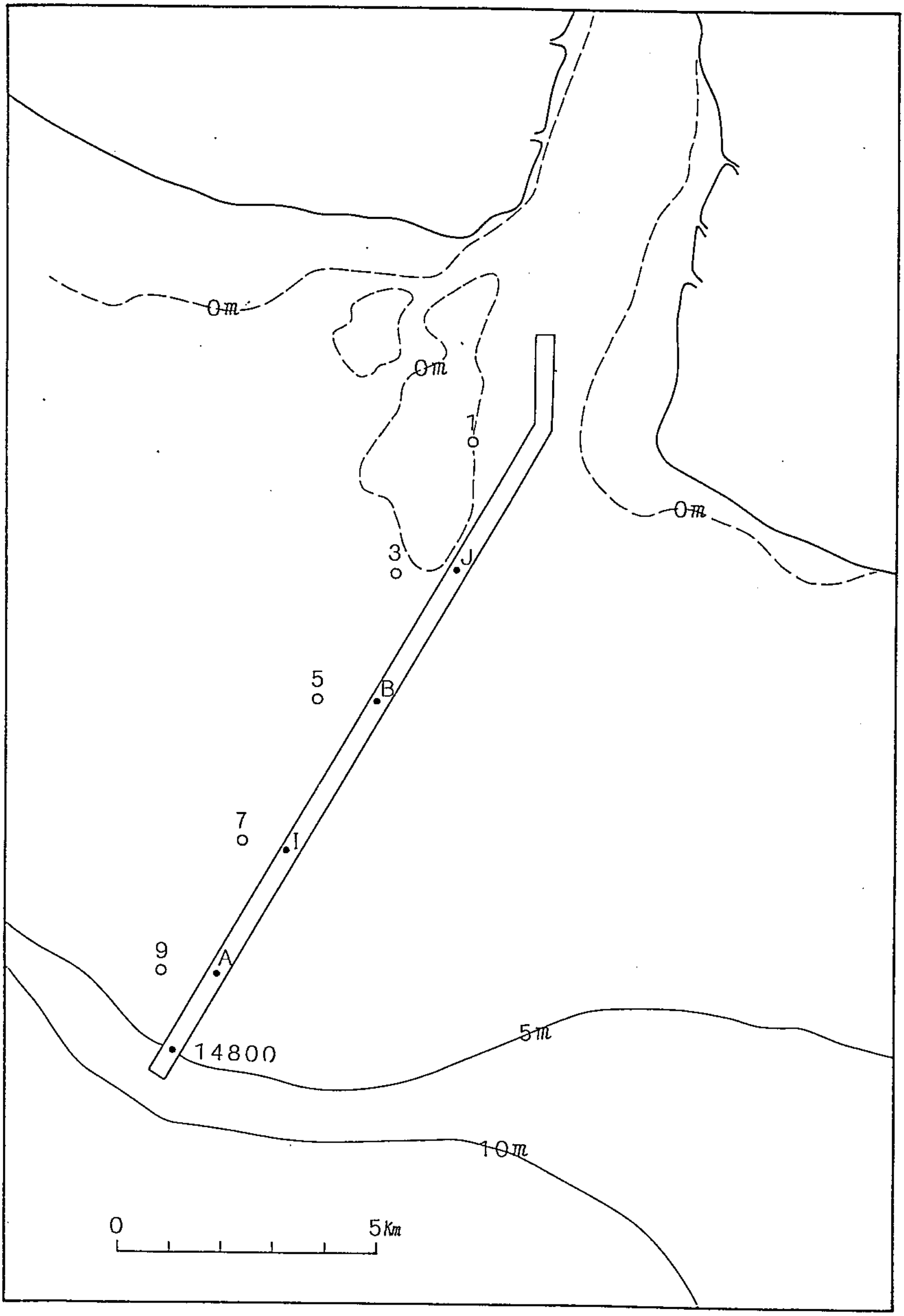


Fig. 5. 4-3 (3) Stations for Seabed Level Survey I

Table 5.4-3(1) Comparision of Water Depths among 210KHz, 33KHz and Lead

(Seabed Level Survey I)

Access Channel Area

Method \ Station		St.J(4,300) Start (m)	St.J(4,300) End (m)	St.B(7,000) Start (m)	St.B(7,000) End (m)	St.I(10,000) Start (m)	St.I(10,000) End (m)	St.A(13,000) Start (m)	St.A(13,000) End (m)	St.14,800 Start (m)	St.14,800 End (m)
Echo-Sounder	210KHz	6.0	6.0	5.8	5.7	6.2	6.0	7.1	7.2	9.2	9.0
	33KHz	8.3	8.8	9.6	8.6	8.4	8.2	7.2	7.3	9.2	9.0
Sounding Lead		7.0	8.3	9.5	8.3	8.2	8.2	7.5	7.5	9.2	9.0

West Side of Access Channel Area

Method \ Station		St.1 Start (m)	St.1 End (m)	St.3 Start (m)	St.3 End (m)	St.5 Start (m)	St.5 End (m)	St.7 Start (m)	St.7 End (m)	St.9 Start (m)	St.9 End (m)
Echo-Sounder	210KHz	3.7	3.7	2.5	2.5	3.2	3.2	3.8	3.8	6.4	6.4
	33KHz	3.8	3.7	2.5	2.5	3.3	3.2	3.8	3.8	6.5	6.4
Sounding Lead		3.8	3.8	2.5	2.5	3.5	3.3	4.0	4.0	6.5	6.5

Table 5.4-3(2) RESULT OF SOIL TEST

(SEA BED LEVEL I)

(Depth) 0 – 50 (cm)

St. 1	St. 3	St. 5	St. 7	St. 9
67.3	83.5	88.3	70.0	124.8
1.585	1.529	1.527	1.575	1.439
77.3	68.4	96.3	71.7	92.5
1.580	1.624	1.492	1.640	1.556
70.3				102.3
1.613				1.451

(Depth) 0 – 50 (cm)

St. J	St. B	St. I	St. A	St. 14.800
145.9	186.1	191.5	165.8	92.1
1.345	1.330	1.319	1.241	1.518
157.1	165.0	192.8	110.5	78.8
1.328	1.363	1.324	1.467	1.525
140.4	149.1	158.4	91.4	
1.357	1.369	1.329	1.475	
113.0	119.4	130.0		
1.471	1.450	1.414		
	75.8	74.6		
	1.525	1.607		

LEGEND

W
γ
W
γ

W: WATER CONTENT. %

γ: BULK DENSITY. g/cm³

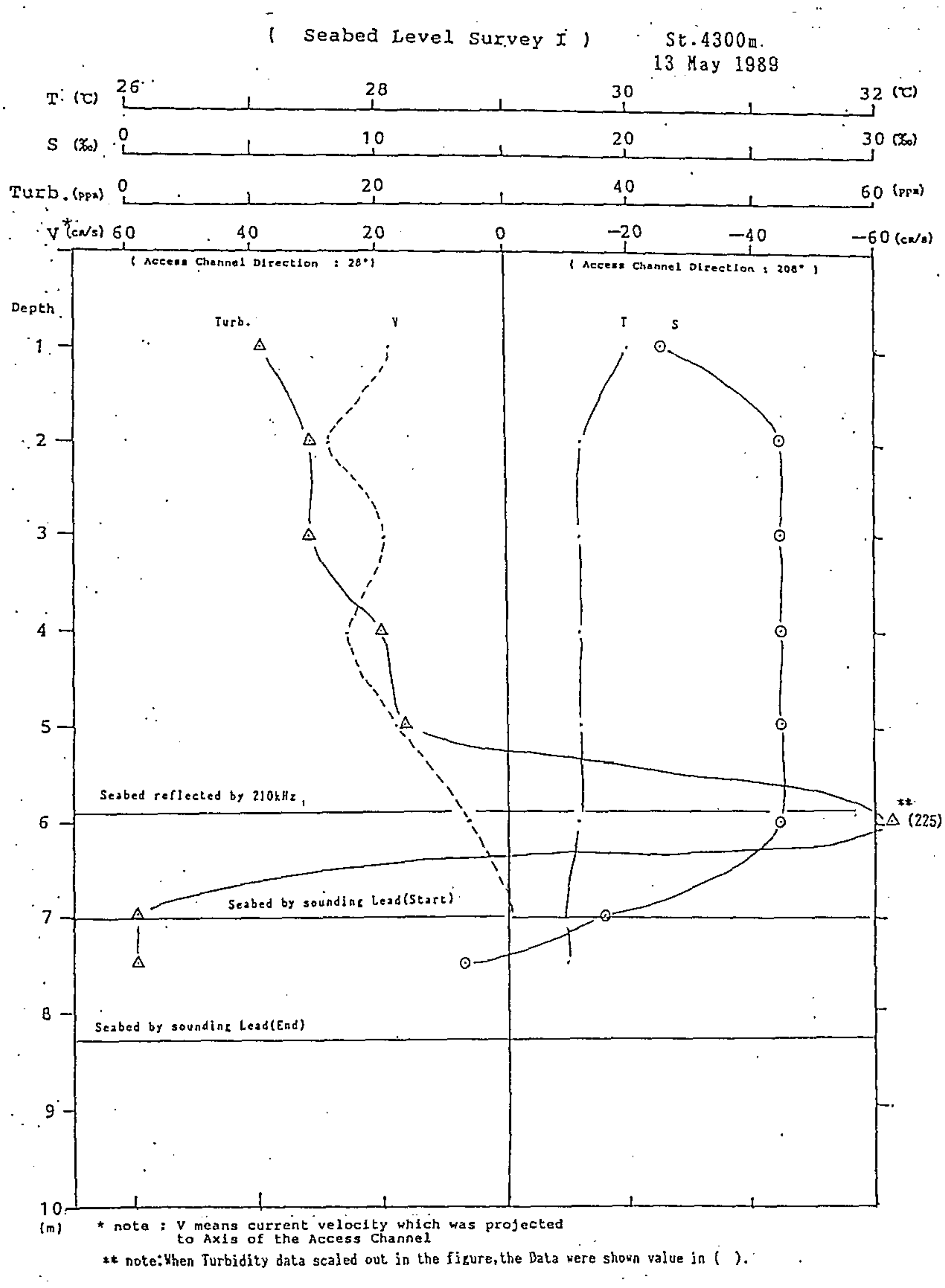


Fig. 5.4-3(4) Vertical Profiles of Water Temperature, Salinity and SS

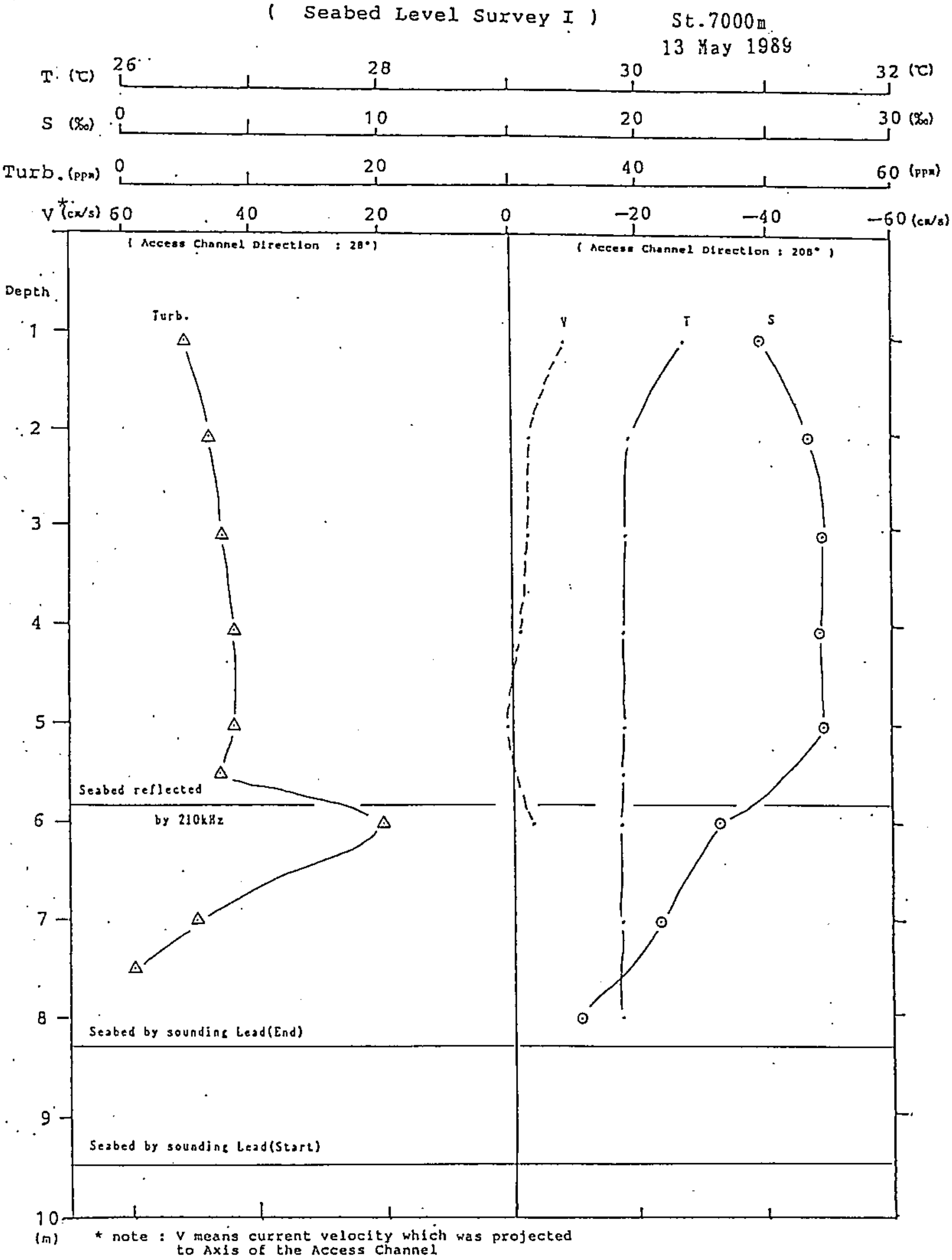


Fig. 5.4-3(5) Vertical Profiles of Water Temperature, Salinity and SS

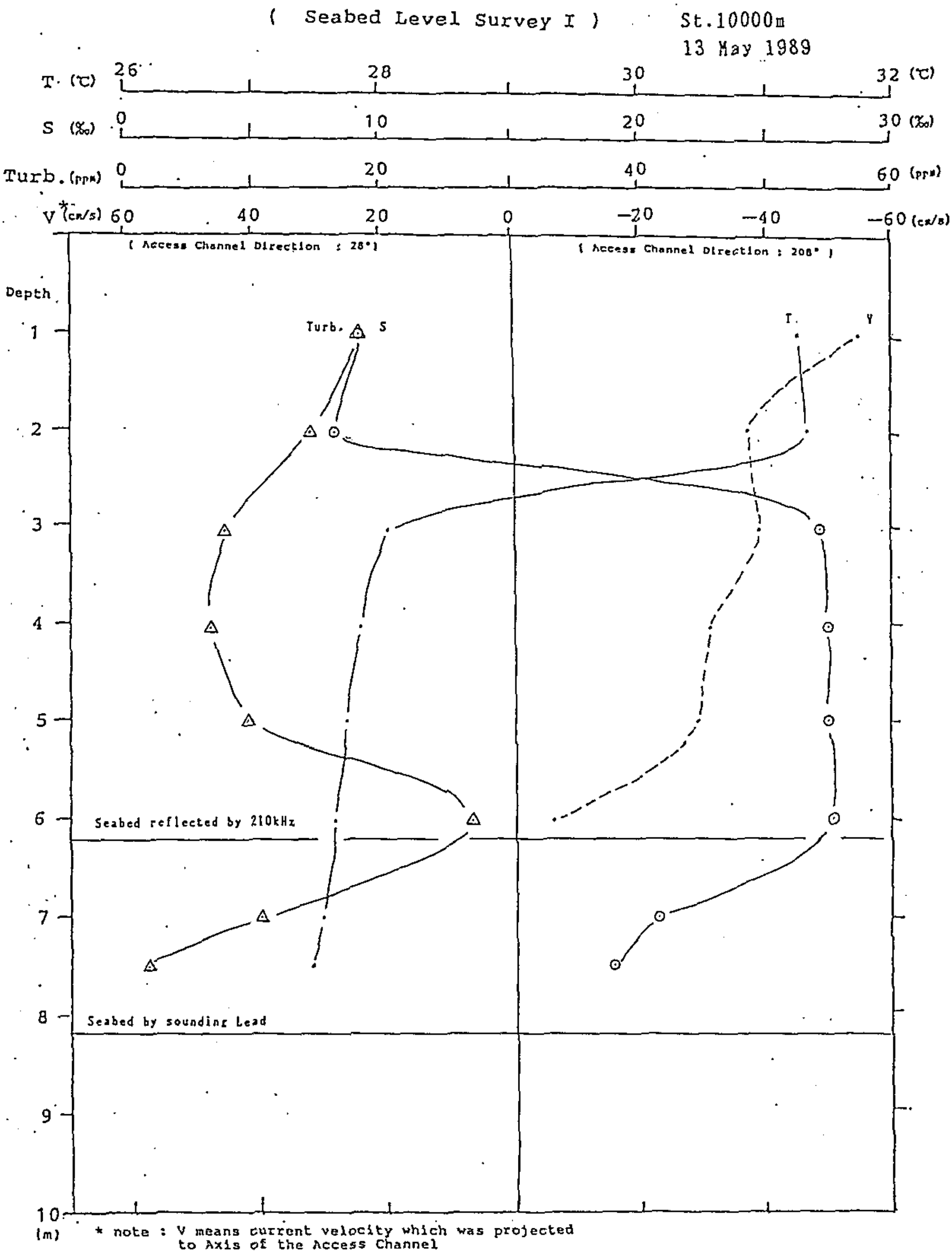


Fig. 5.4-3(6) Vertical Profiles of Water Temperature,Salinity and SS

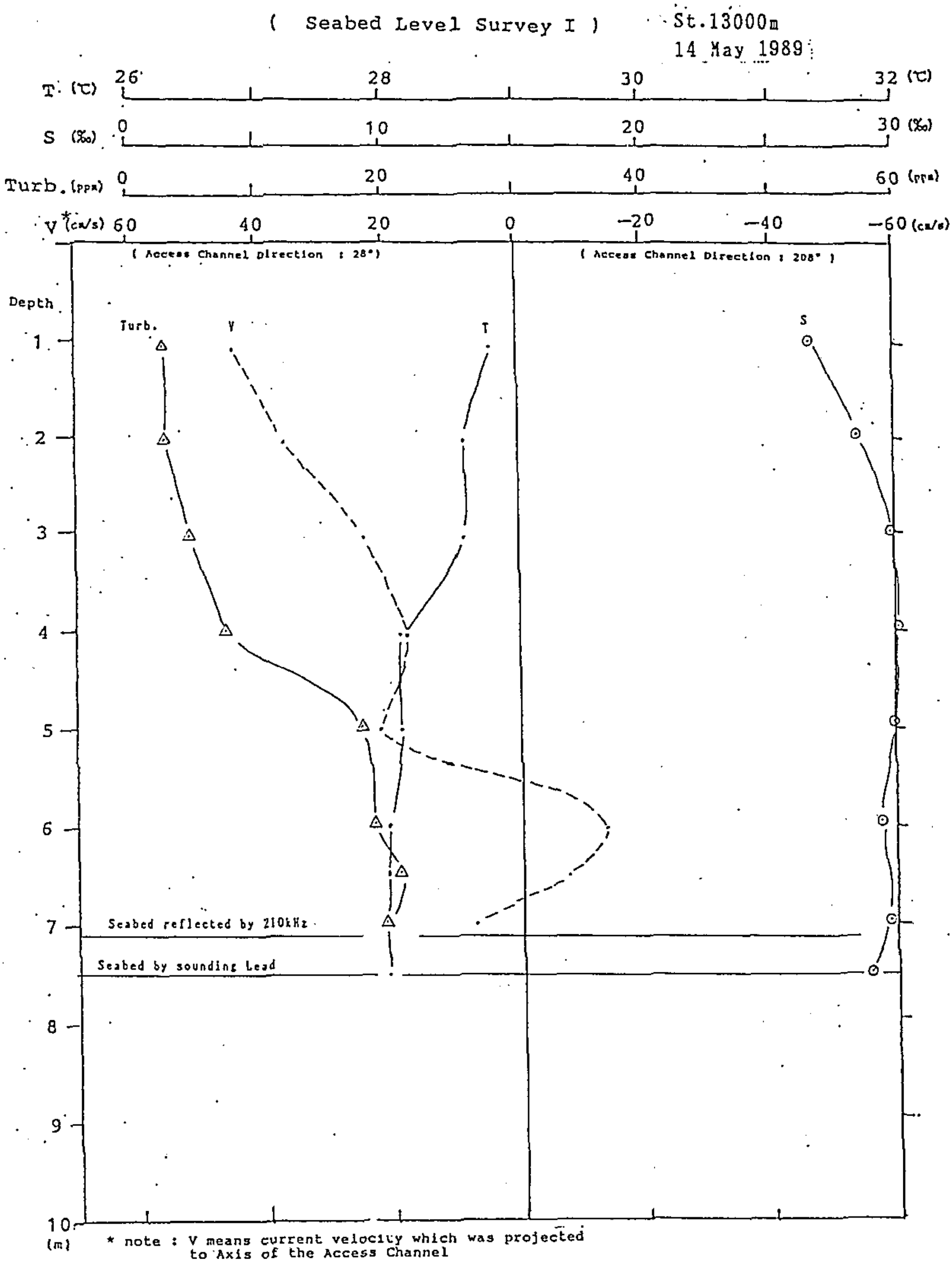


Fig. 5.4-3(7) Vertical Profiles of Water Temperature, Salinity and SS

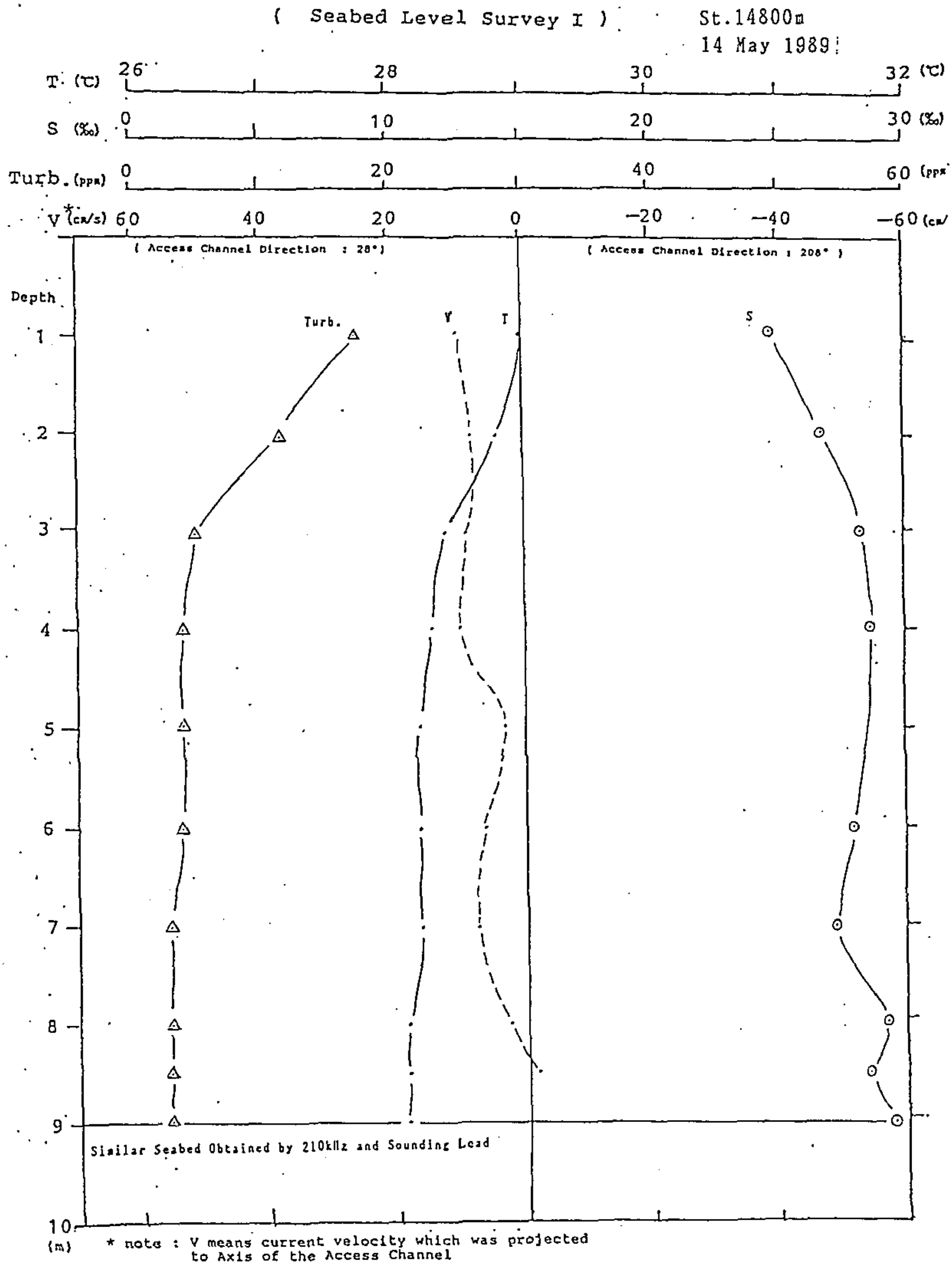


Fig. 5.4-3(8) Vertical Profiles of Water Temperature, Salinity and SS

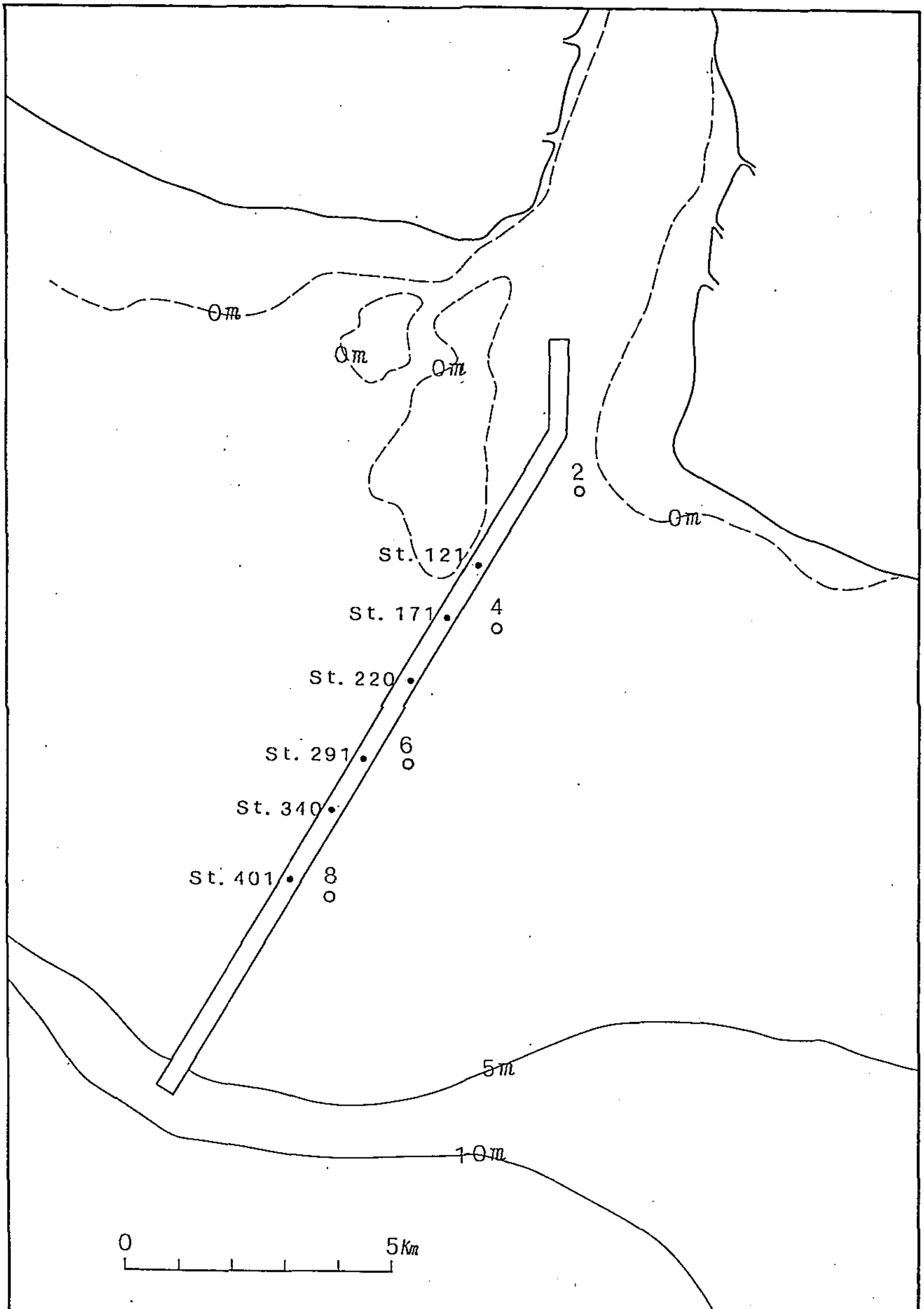


Fig. 5. 4-3 (9) Stations for Seabed Level Survey II

Table 5.4-3(3) Comparision of Water Depths among 210KHz, 33KHz and Lead

(Seabed Level Survey II)

Access Channel Area

Method \ Station		St.121 Start (m)	St.121 End (m)	St.171 Start (m)	St.171 End (m)	St.220 Start (m)	St.220 End (m)	St.291 Start (m)	St.291 End (m)	St.341 Start (m)	St.341 End (m)	St.401 Start (m)	St.401 End (m)
Echo-Sounder	210KHz	4.8	4.7	5.2	5.2	5.5	5.5	6.0	5.9	6.2	6.1	8.0	7.4
	33KHz	7.1	7.3	7.1	7.2	8.4	8.6	7.2	7.0	6.7	6.4	8.3	8.5
Sounding Lead		7.1	7.4	7.5	8.6	8.5	8.0	8.0	7.5	6.5	6.7	8.3	8.9

East Side of Access Channel Area

Method \ Station		St.8 Start (m)	St.8 End (m)	St.6 Start (m)	St.6 End (m)	St.4 Start (m)	St.4 End (m)	St.2 Start (m)	St.2 End (m)
Echo-Sounder	210KHz	3.5	3.5	3.2	3.2	4.6	4.6	4.7	4.7
	33KHz	3.5	3.5	3.2	3.2	4.6	4.6	4.7	4.7
Sounding Lead		3.5	3.6	3.3	3.3	4.6	4.7	4.7	4.7

Table 5.4-3 (4) RESULT OF SOIL TEST

(SEA BED LEVEL Ⅱ)

Depth: 0 – 50 (cm)

St. 121	St. 171	St. 220	St. 291	St. 340	St. 401
191.5	160.5	194.0	181.9	147.4	106.2
1.313	1.338	1.282	1.334	1.359	1.398
234.9	146.2	157.0	143.2	129.8	107.2
1.257	1.412	1.350	1.383	1.482	1.372
173.9	144.0	187.9	141.8	115.4	
1.277	1.451	1.325	1.348	1.440	
122.7	106.1	126.5	122.8	110.1	
1.377	1.446	1.416	1.394	1.419	
112.4		91.6	82.2		
1.371		1.452	1.553		

Depth: 0 – 50 (cm)

St. 2	St. 4	St. 6	St. 8
144.5	221.5	111.0	62.8
1.431	1.247	1.363	1.647
109.9	140.0	63.4	
1.461	1.366	1.598	
124.1	62.9		
1.375	1.595		
93.8			
1.394			

LEGEND

W
γ
W
γ

W: WATER CONTENT. %

γ: BULK DENSITY. g/cm³

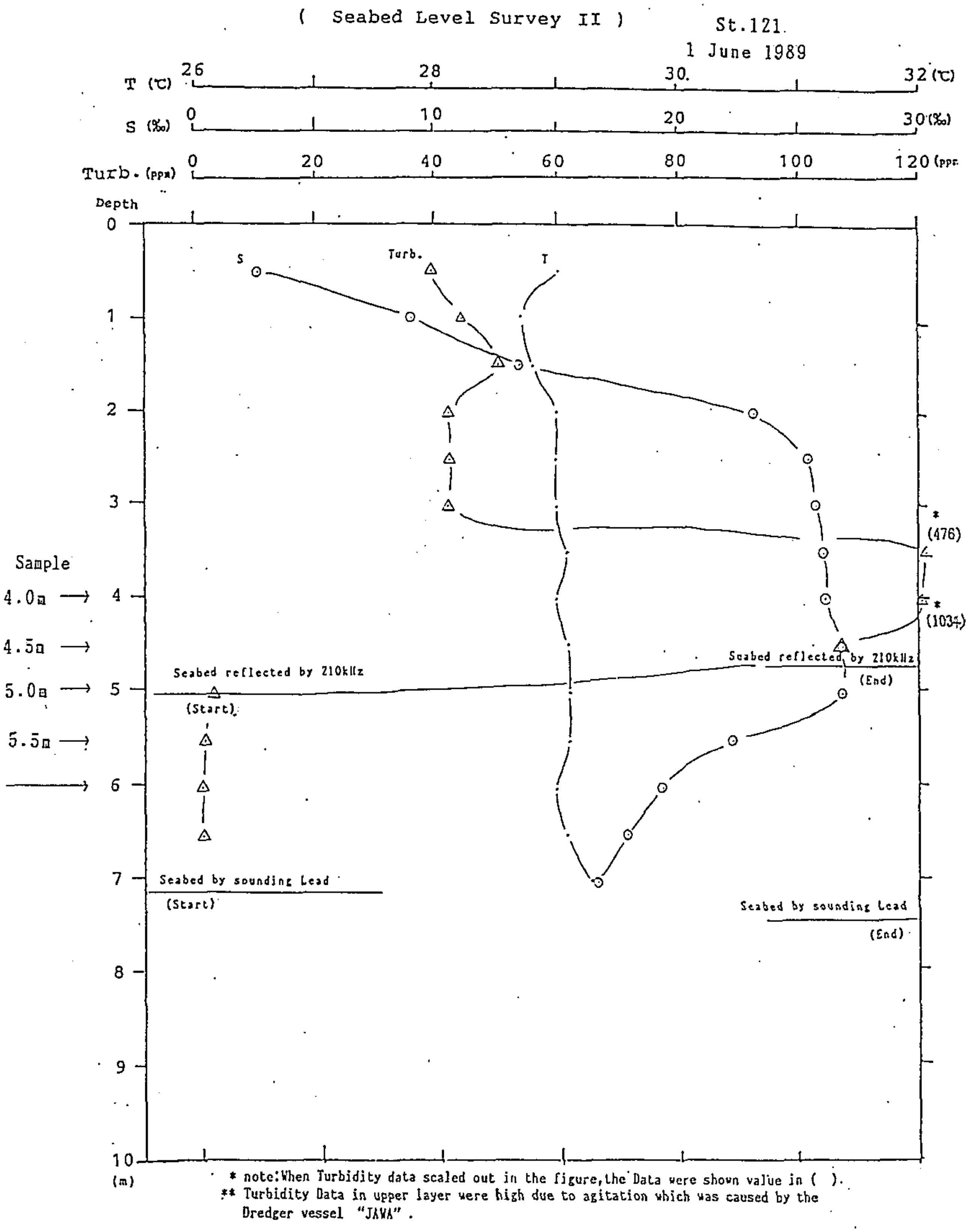


Fig. 5.4-3(10) Vertical Profiles of Water Temperature,Salinity and SS

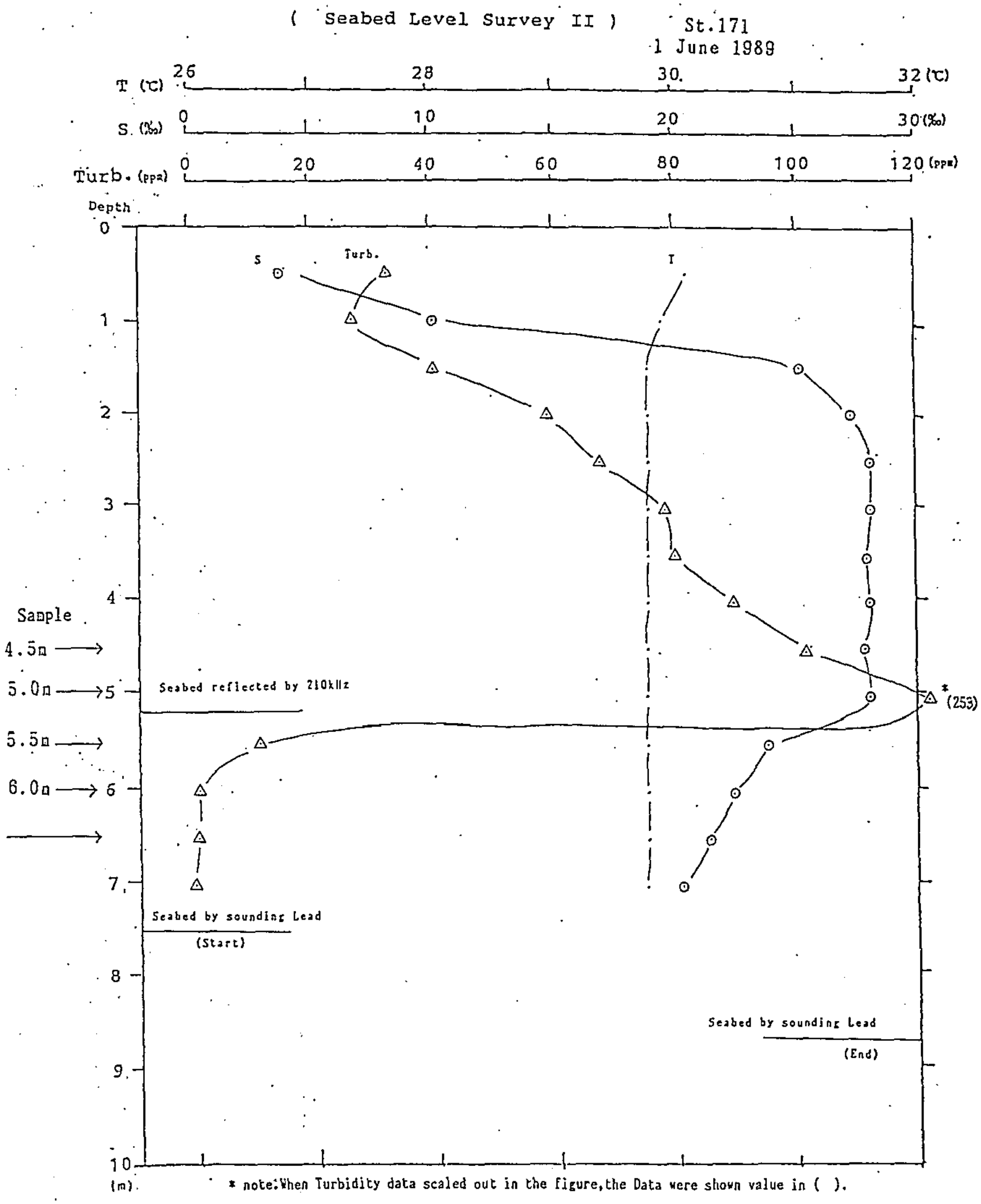


Fig. 5.4-3(11) Vertical Profiles of Water Temperature,Salinity and SS

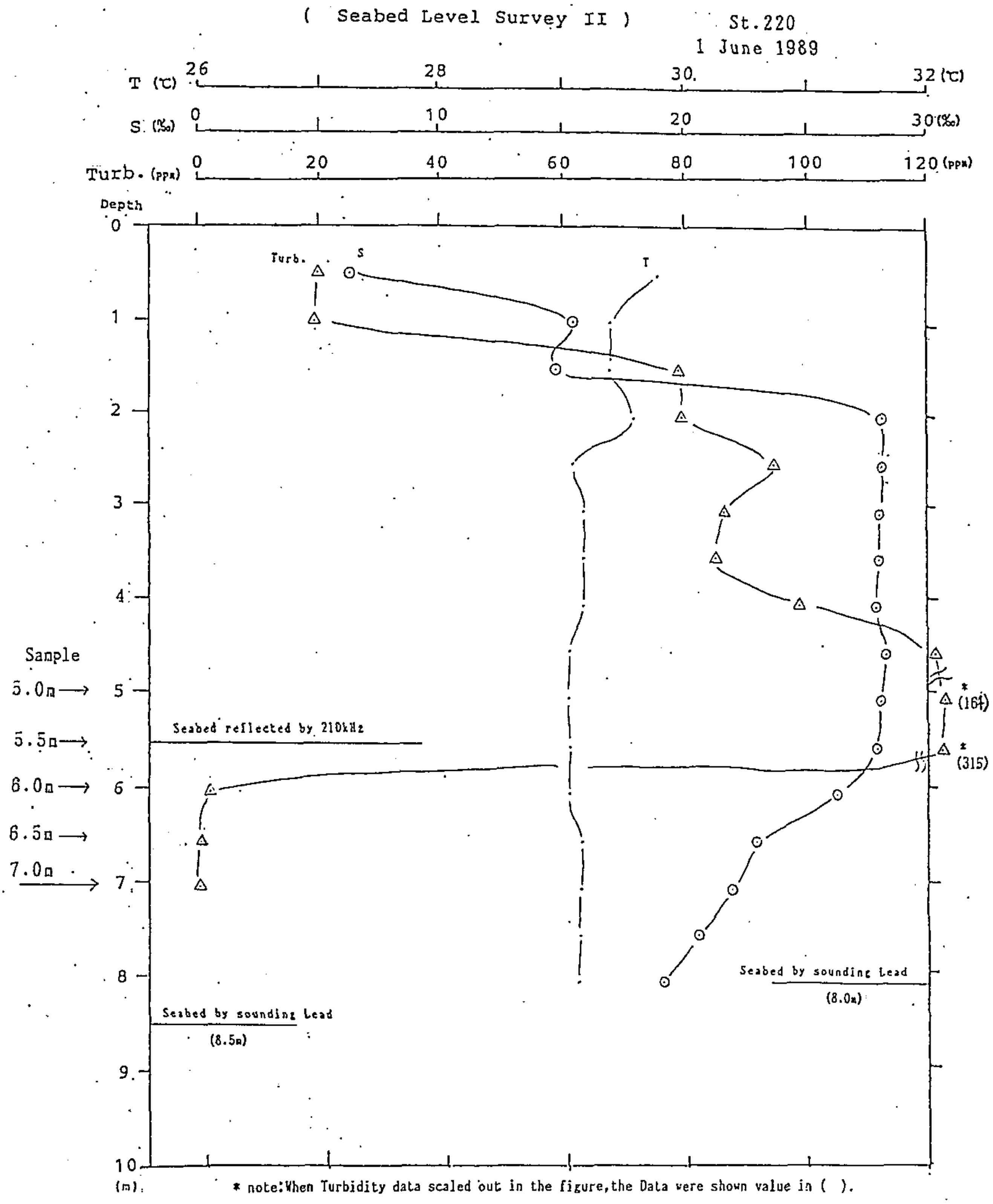


Fig. 5.4-3(12) Vertical Profiles of Water Temperature, Salinity and SS

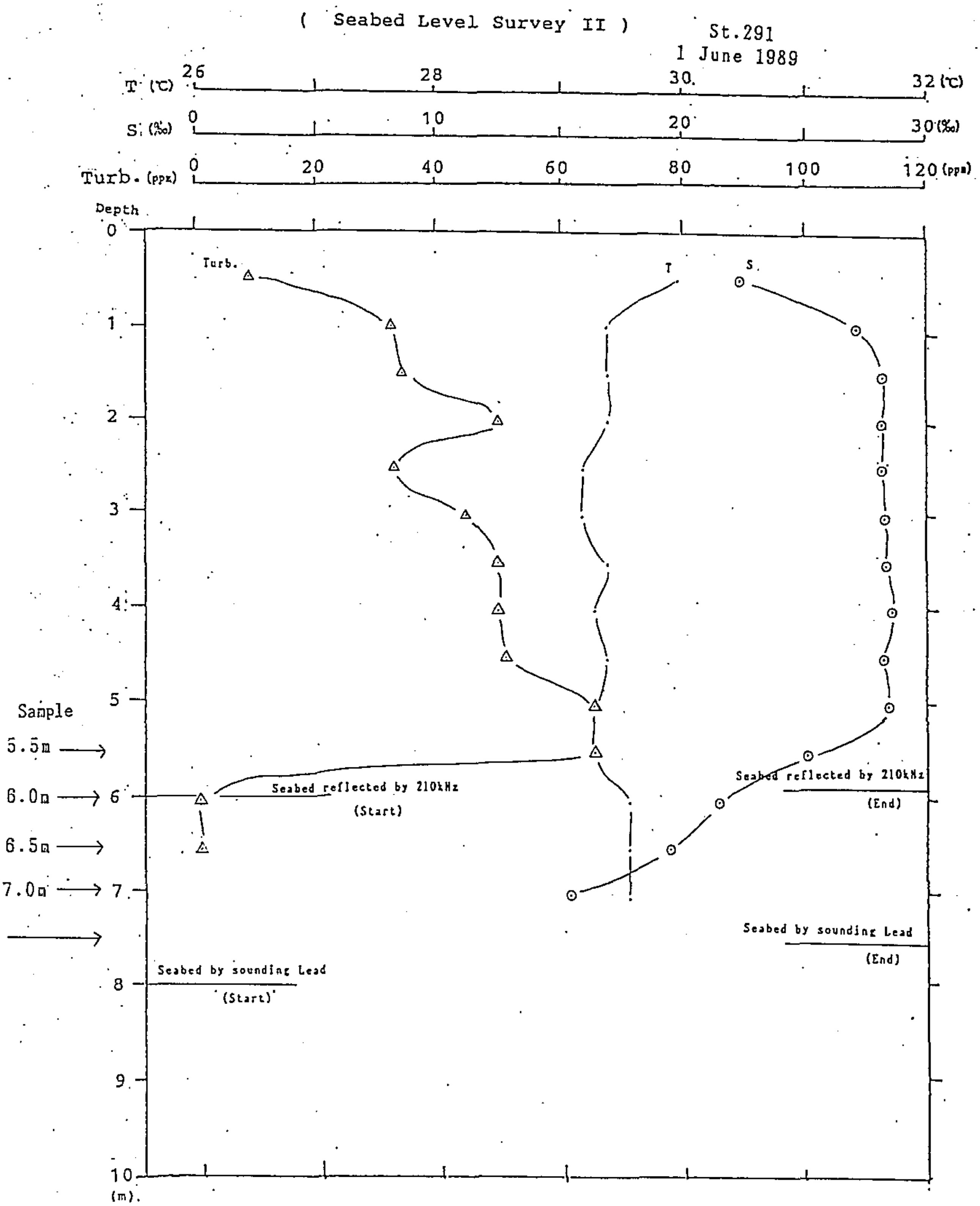


Fig. 5.4-3(13) Vertical Profiles of Water Temperature,Salinity and SS

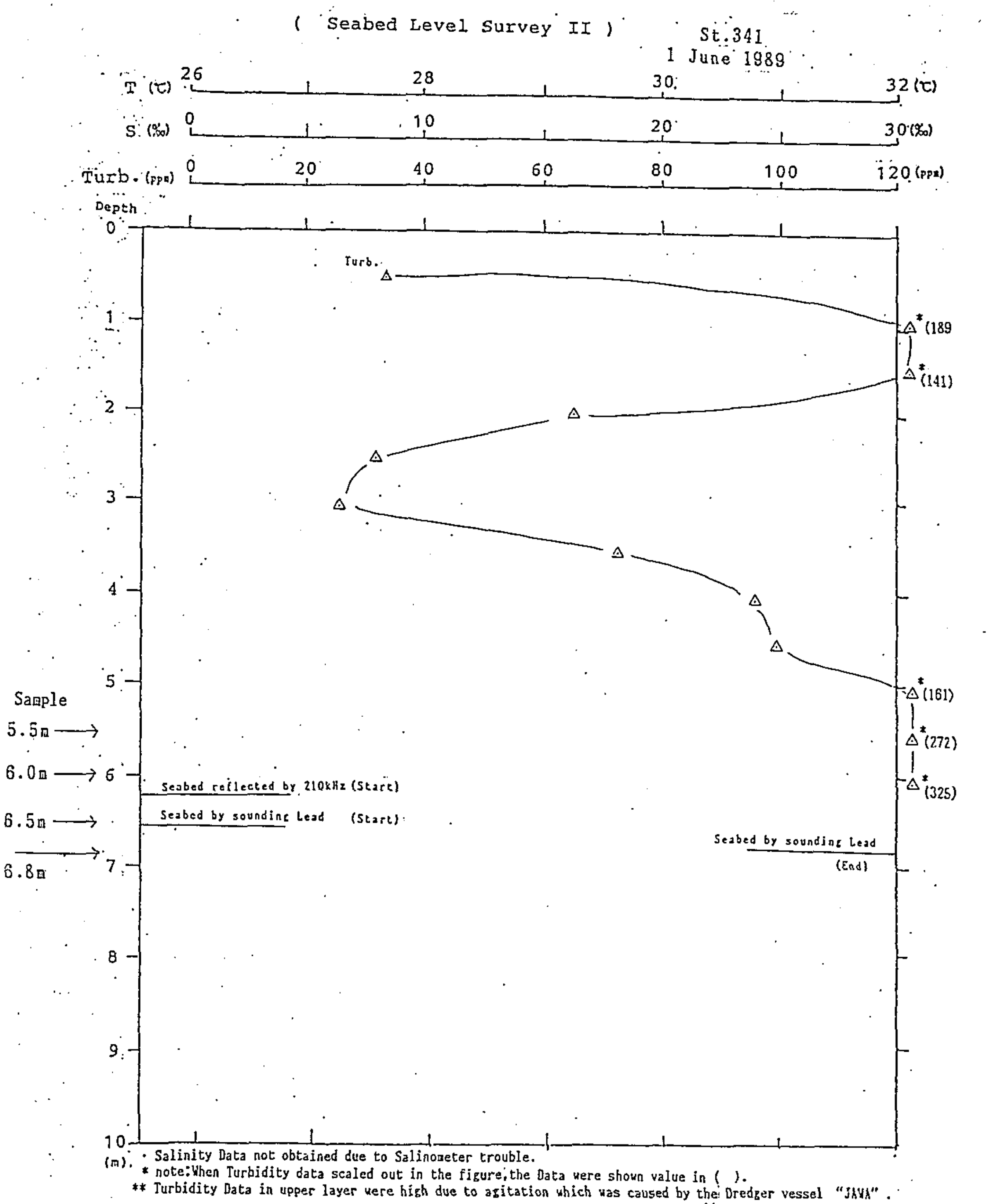


Fig. 5.4-3(14) Vertical Profiles of Water Temperature,Salinity and SS

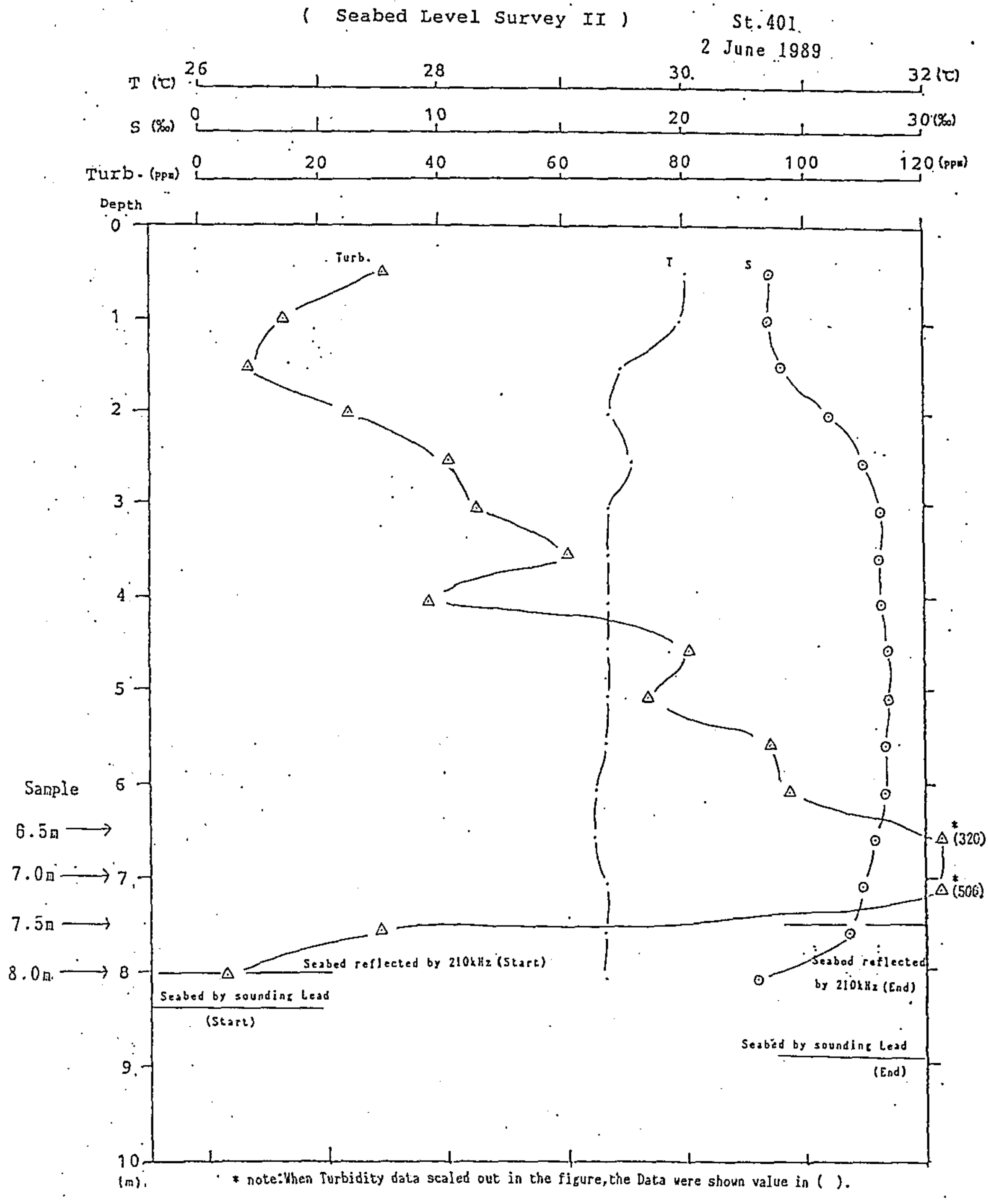


Fig. 5.4-3(15) Vertical Profiles of Water Temperature,Salinity and SS

5.5 Existing Data

5.5.1 Analysis of Landsat Data

1) Data Processing

Five Landsat satellites launched between 1972 and 1984 by NASA (National Aeronautics Space and Administration), U.S.A. In this study, we use the digital data obtained by the two visible and near infrared sensors, the Multi Spectral Scanner(MSS) aboard Landsat-1,2,3,4 and 5, and the Thematic Mapper(TM) aboard Landsat-4 and 5.
These sensors detects electromagnetic radiation reflected on the earth and records it in several different spectral bands in digital form.(Table 5.5.1-1)
These Landsat digital data is available in the form of CCTs (computer compatible tapes), and can be processed by computing numerically or can be processed to produce black-and-white and color composite image.

Flow chart of the Landsat digital data processing is shown in Fig 5.5.1-1.
In the first step noise reduction is done, secondly, the image data in CCT are rearranged onto the Universal Transverse Mercator projection using G.C.P(Ground Control Points) and Hermart transformation.

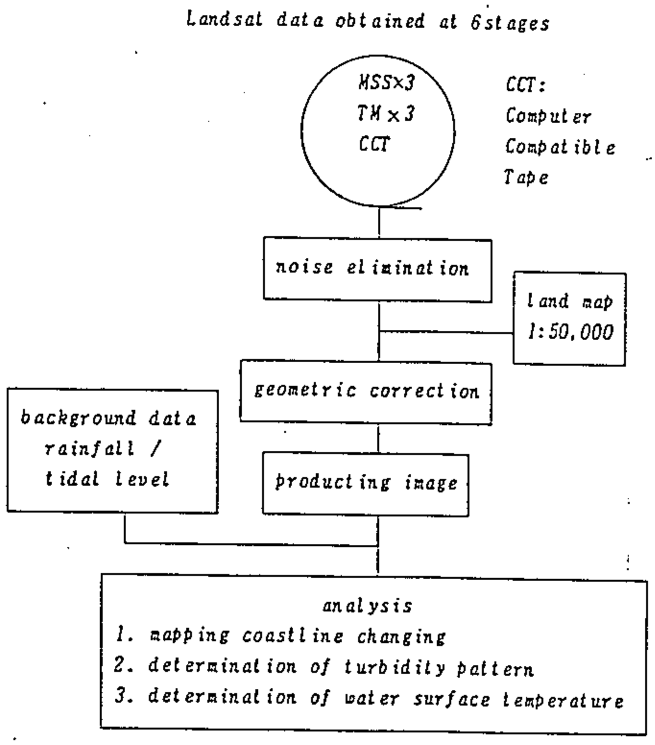


Fig. 5.5.1-1 Flow of Landsat data processing

Table 5.5.1-1(1) Characteristics of MSS

Satellite / Image Scale	LANDSAT - 1, 2, 3		LANDSAT - 4, 5	
Ground coverage Ground Resolution	185 km 57 × 79 m		185 km 68 × 83 m	
Spectral Bands	Wave Length (μm)	Color	Wave Length (μm)	Color
4	0.5 ~ 0.6	green(visible)	0.495 ~ 0.605	green(visible)
5	0.6 ~ 0.7	red (visible)	0.603 ~ 0.698	red (visible)
6	0.7 ~ 0.8	near infrared	0.701 ~ 0.813	near infrared
7	0.8 ~ 1.1	near infrared	0.808 ~ 1.023	near infrared

Table 5.5.1-1(2) Characteristics of TM

Satellite / Image Scale	LANDSAT - 4, 5	
Ground coverage Ground Resolution	185 km 30m, 120m(band 6)	
Spectral Bands	Wave Length (μm)	Color
1	0.45~ 0.52	blue (visible)
2	0.52~ 0.60	green(visible)
3	0.63~ 0.69	red (visible)
4	0.76~ 0.90	near infrared
5	1.55~ 1.75	near infrared
6	10.4~ 12.5	thermal infrared
7	2.08~ 2.35	near infrared

Note 1 : Ground coverage is the area that single image cover over.
Note 2 : Ground resolution is the picture element area (pixel) sampled by the sensors.

2) Data analyzed

In this study, we use the six Landsat digital data, three are MSS data and the others are TM data, as shown in Table 5.5.1-2.
These six viewing time was selected for study of coastline changes long-term, and for seasonal investigation of water quality.
In order to compare with these image data, we obtained the rainfall data and the tidal level data at the six stages from 1973 to 1989, as shown in Fig. 5.5.1-2 and 5.5.1-3.
Tide levels in Fig.5.5.1-3(1)-(5) are the predicted value based on the harmonic constant calculated from the tidal harmonic analysis results made by Indonesian Navy(Source: Final Report of Technical Survey for Port of Banjarmasin, 1984),and shown in Fig.5.5.1-3(6) is observed value at station during the Yearlong Survey.

Table 5.5.1-2 Landsat Data

Date / (Local time)	9 Oct. 1973 (10:01)	1 May. 1984 (10:01)	9 Oct. 1987 (10:02)	18 Apr. 1988 (10:05)	21 Jun. 1988 (10:05)	10 Jul. 1989 (10:02)
Satellite / Sensor	LANDSAT-1 MSS	LANDSAT-4 MSS	LANDSAT-5 MSS	LANDSAT-5 TM	LANDSAT-5 TM	LANDSAT-5 TM
Path-Row	126 - 62	118 - 62	118 - 62	118 - 62	118 - 62	118 - 62
Data form	uncorrected	uncorrected	uncorrected	BULK product	BULK product	uncorrected
Obtained from	EOSAT	TRSC	TRSC	TRSC	TRSC	TRSC
Others / Season	dry season	rainy season	dry season	rainy season	rainy season	end of rainy season
Tide stage	around low	higher low	ebb	ebb	flood around high	flood around high

Note 1 : EOSAT ··· EARTH OBSERVATION SATELLITE COMPANY (U.S.A)
Note 2 : TRSC ··· THAILAND REMOTE SENSING CENTER , NATIONAL RESEARCH COUNCIL OF THAILAND (TAHILAND)

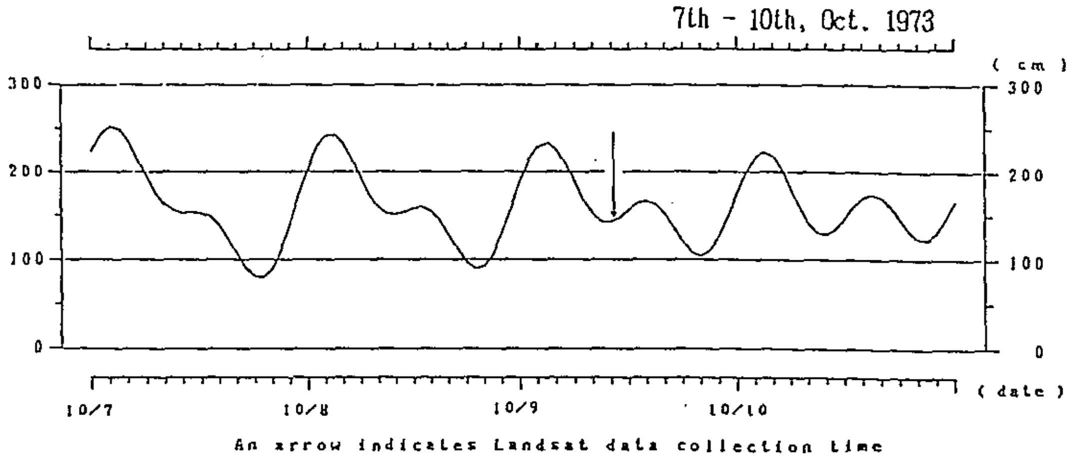


Fig. 5.5.1-2(1) Predicted Tidal level (Oct. 1973)

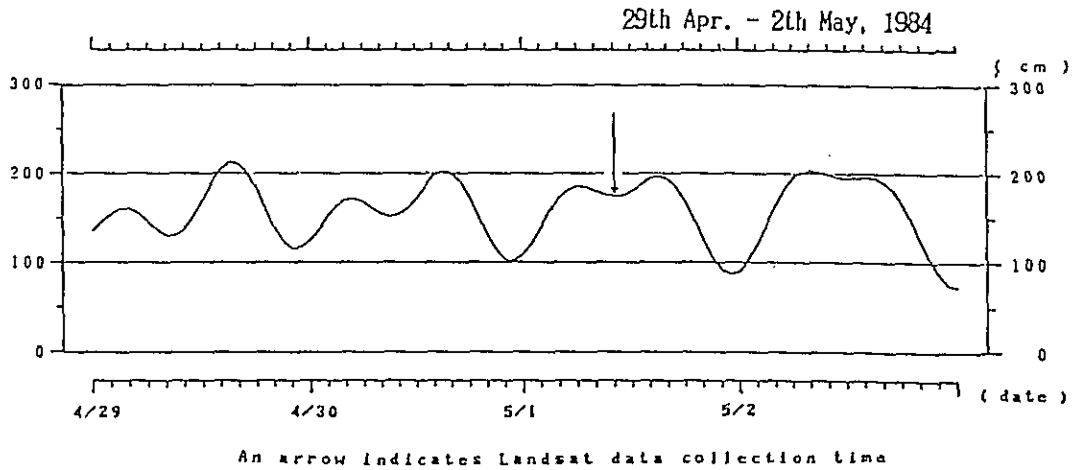


Fig. 5.5.1-2(2) Predicted Tidal level (May 1984)

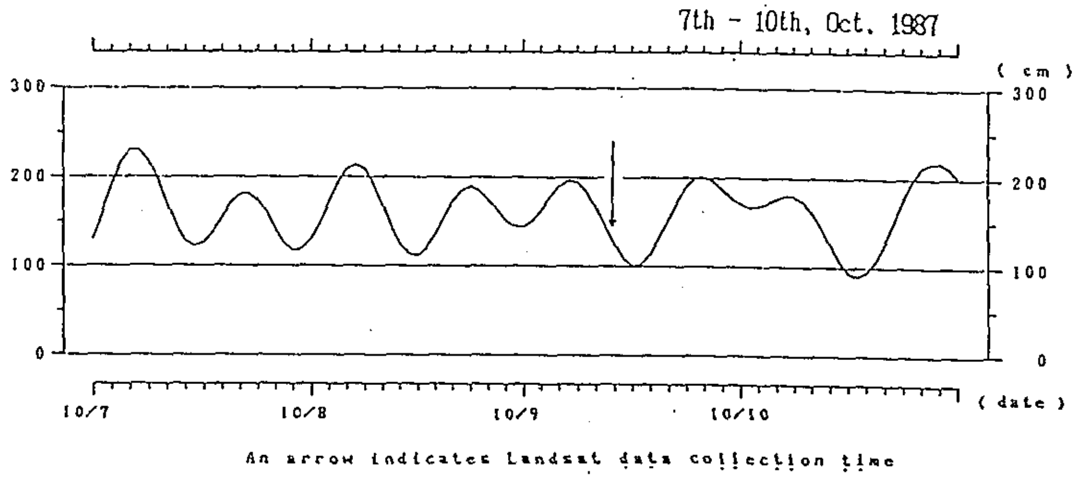


Fig. 5.5.1-2(3) Predicted Tidal level (Oct. 1987)

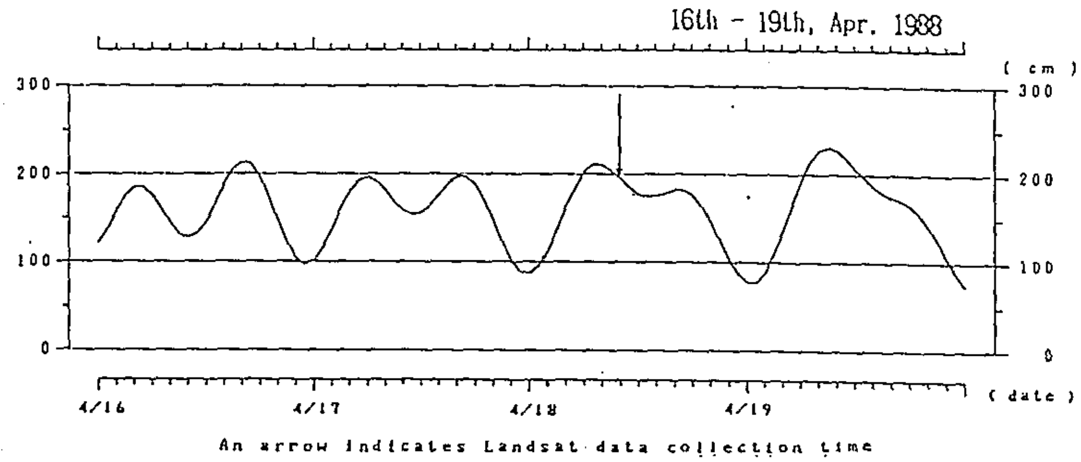


Fig. 5.5.1-2(4) Predicted Tidal level (Apr. 1988)

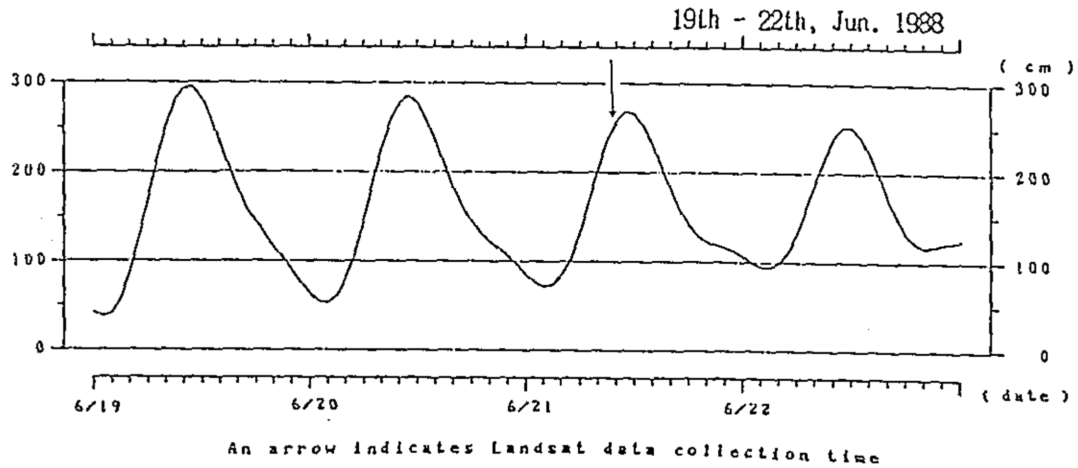


Fig. 5.5.1-2(5) Predicted Tidal level (Jun. 1988)

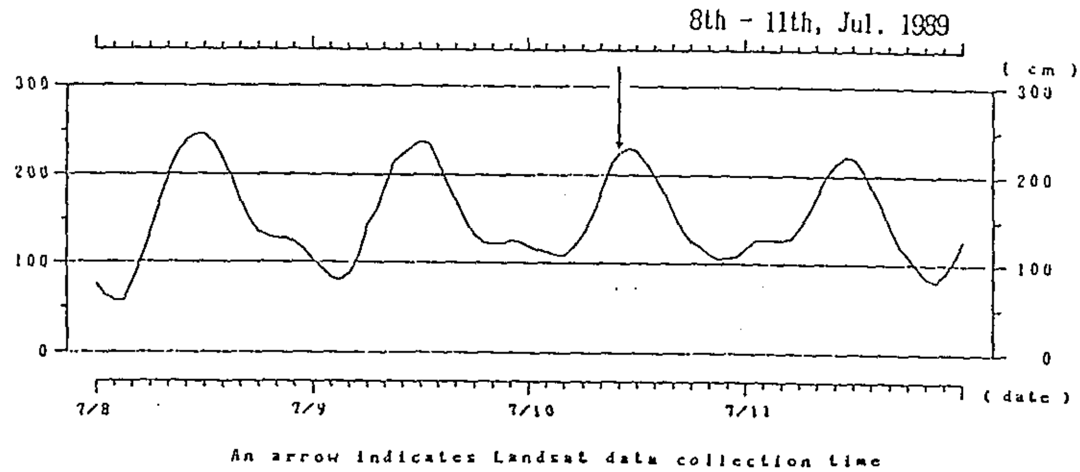


Fig. 5.5.1-2(6) Observed Tidal level (Jul. 1989)

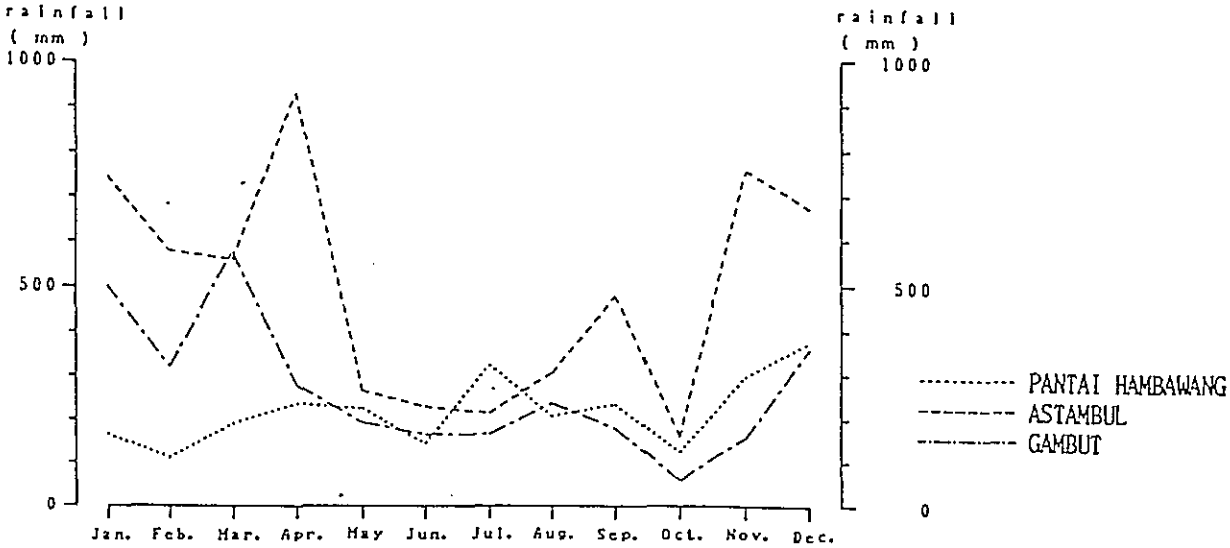


Fig. 5.5.1-3(1) Monthly Rainfall (1973)

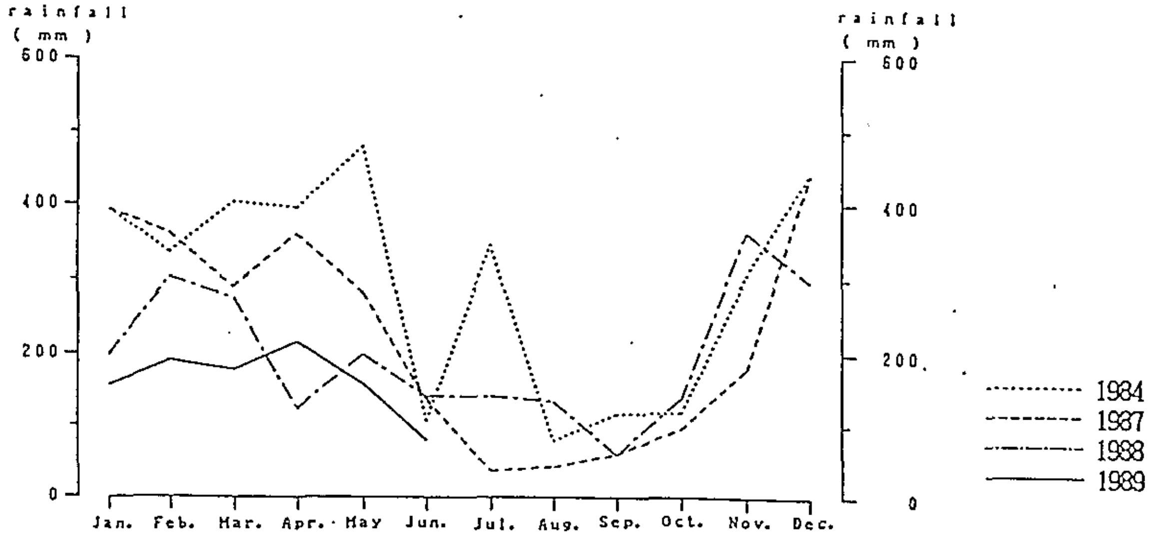


Fig. 5.5.1-3(2) Monthly Rainfall at Banjarmasin (1984,1987,1988,1989)

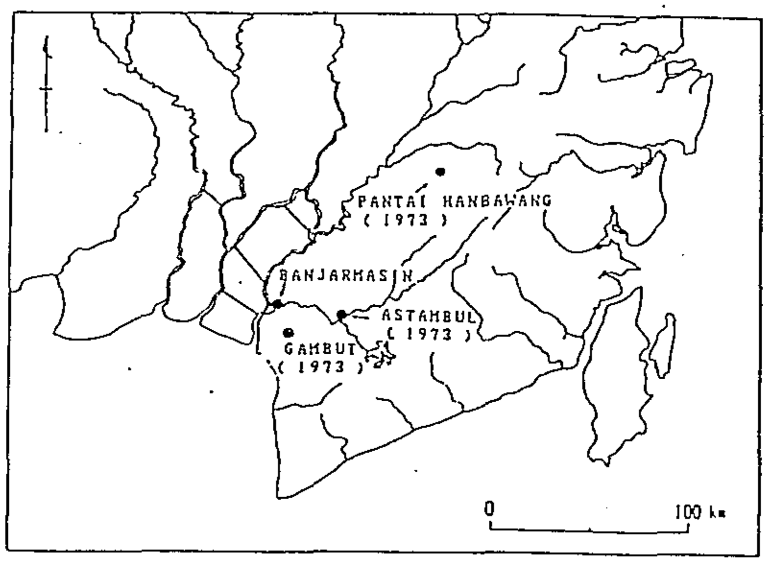


Fig. 5.5.1-3(3) Location of Observation Stations

3) Method of Analysis

(1) Mapping of Coastline Changes

Single scene of Landsat cover over about 185km square and the study area of the Barito estuarine can be seen in a TM image with 30m ground resolution or in a MSS image with 80m resolution.

We can define coastal boundaries, configuration of developed vegetation at seaside in a false color composite image.
The false color composite method by using the following filter and bands:

	(MSS)	(TM)
Blue filter	Band4	Band2
Green filter	Band5	Band3
Red filter	Band6	Band4

In this color composite image, forest is shown in red, farmland in pink or light red, urban areas, marshes and fields with water in light blue, polluted water in faint blue and ordinary water in dark blue.
These images are produced at scale 1:200,000, and mapped.

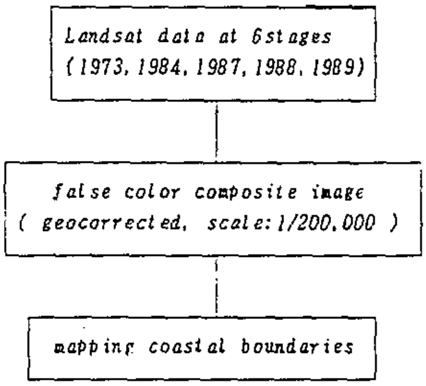


Fig. 5.5.1-4 Method of Mapping Coastline changes

(2) Determination of Turbidity Patterns

We can measure sediment and turbidity patterns with investigating of water colors.
Generally, visible wavelength remotely sensed data which obtained above sea are affected by following elements;

(a) Absorption of skylight
(b) Specular reflection of sea surface
(c) Scattering of suspended particles, as inorganic sediments, phytoplankton, zooplankton, algae, or a combination of these
(d) Bottom reflectance and water attenuation (reflection of bottom sediments)

If the suspended particles in a water body increase, the mount of energy backscattered from water bodies increase, then reflectance and absorbance characteristics of suspended particles affect the spectral distribution of backscattering energy.

Clear water body has high transmittance characteristics in visible wavelength, and absorb near infrared wavelength energy well.
It shows blue color, because small wavelength are scattered most.
When suspended particles increase in water body, as turbidity increasing, scattering energy become more long wavelength and water color shifts to green, red, or the natural color of the particles finally.

As water turbidity is affected by the concentration, size, shape and refractive characteristics of suspended particle, so we can get information of water turbidity from remotely sensed data.
We give a description of relative turbidity distribution of the Barito estuarine with the analysis of spectral characteristic of sea and river water by using Landsat multispectral imagery and the principal component analysis of them.
In addition, TM data acquired on 10th July, 1989 is analyzed combining with sea-truth data, water quality parameters measured around Landsat flying time, in the 12th Saline Wedge Survey. And we try to apply Landsat data for quantitative analysis of turbidity.

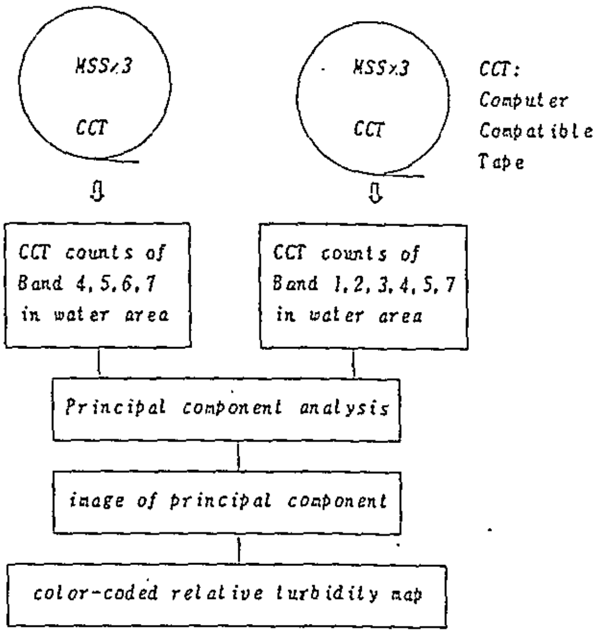


Fig. 5.5.1-5 Method of Determination of Turbidity pattern

(3) Determination of Surface Temperature Patterns

TM aboard Landsat-5 has the thermal infrared capability of band6 (10.4-12.5 micro meters).
Quantitative analysis of satellite thermal infrared image requires calibration data measured at the surface, or the data necessary for estimation of the absorption effect by vapor in the atmosphere.
During this study sufficient calibration data with TM data were not obtained on 10th July, 1989, no correction has made for radiometric calibration for converting absolute temperature and for atmospheric contamination.

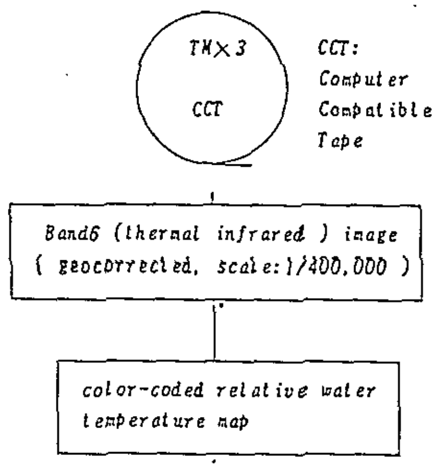


Fig. 5.5.1-6 Method of Determination of Water temperature patter

2) Results

(1) Mapping of Coastline Changes (front of the vegetation)

Changes of the coastline of the Barito estuarine from 1973 to 1989 is mapped in Fig. 5.5.1-7(1)-(4).
In the Barito estuarine, vegetation is dominant at the boundary between the sea and the land, and they are considered as Mangloves.
Comparing with 1973 and 1984, there is clear advance of the vegetation on the coastline between the Barito and the Kapuas river.
In 1973, tidal flat was recognized along this coastline and it seems that the same zone has covered with vegetation in 1984.
Comparing with 1984 and 1987, there cannot be seen relative changes rather than in with 1973 and 1984.
And comparing with 1987 and 1988, and 1988 and 1989 at 1 year interval cases, it was difficult to detect the difference between coastlines.
So coastline condition were compared with 1987 and 1989.
It is concluded that the changes of vegetation front can not be recognized clearly in 1 year applying Landsat images at scale of 1:200,000.
We show the false color composite images of 1973 and 1988 in Fig. 5.5.1-7(5)and(6), with no cloud coverage, and clearly show the old and new coastline, the front of the vegetation.

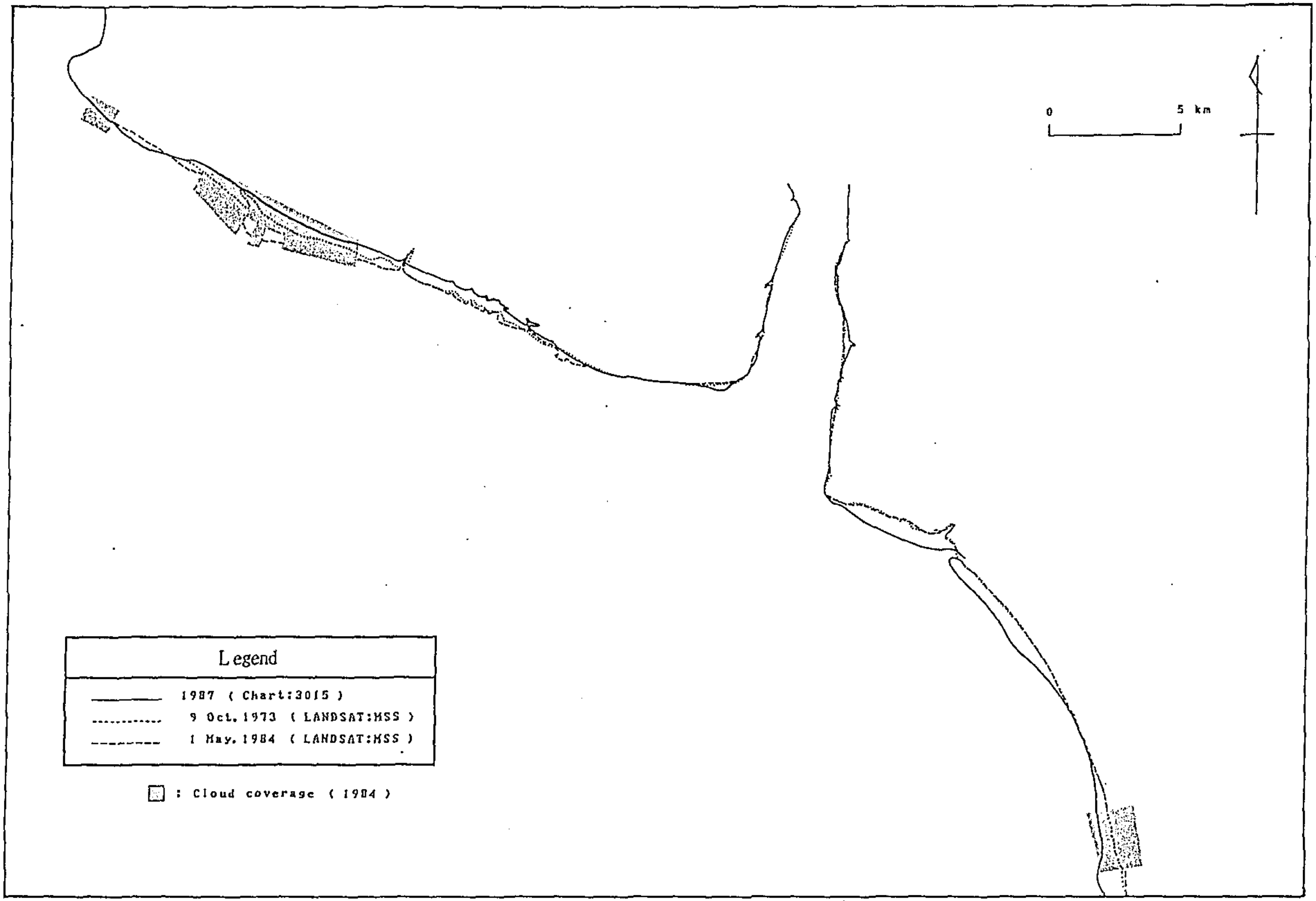


Fig. 5.5.1-7(1) Changes of Coastline(1973-1984)

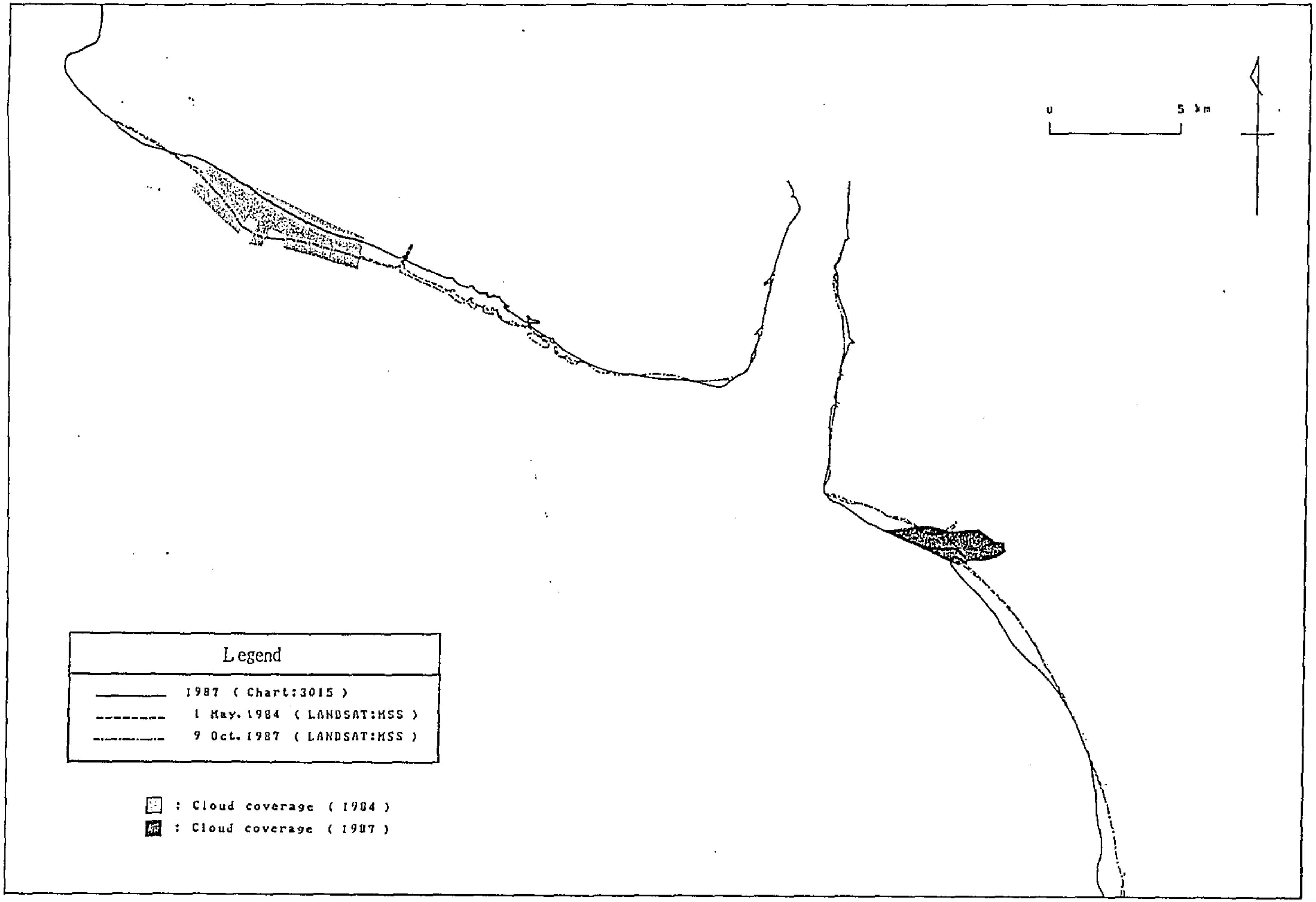


Fig. 5.5.1-7(2) Changes of Coastline(1984-1987)

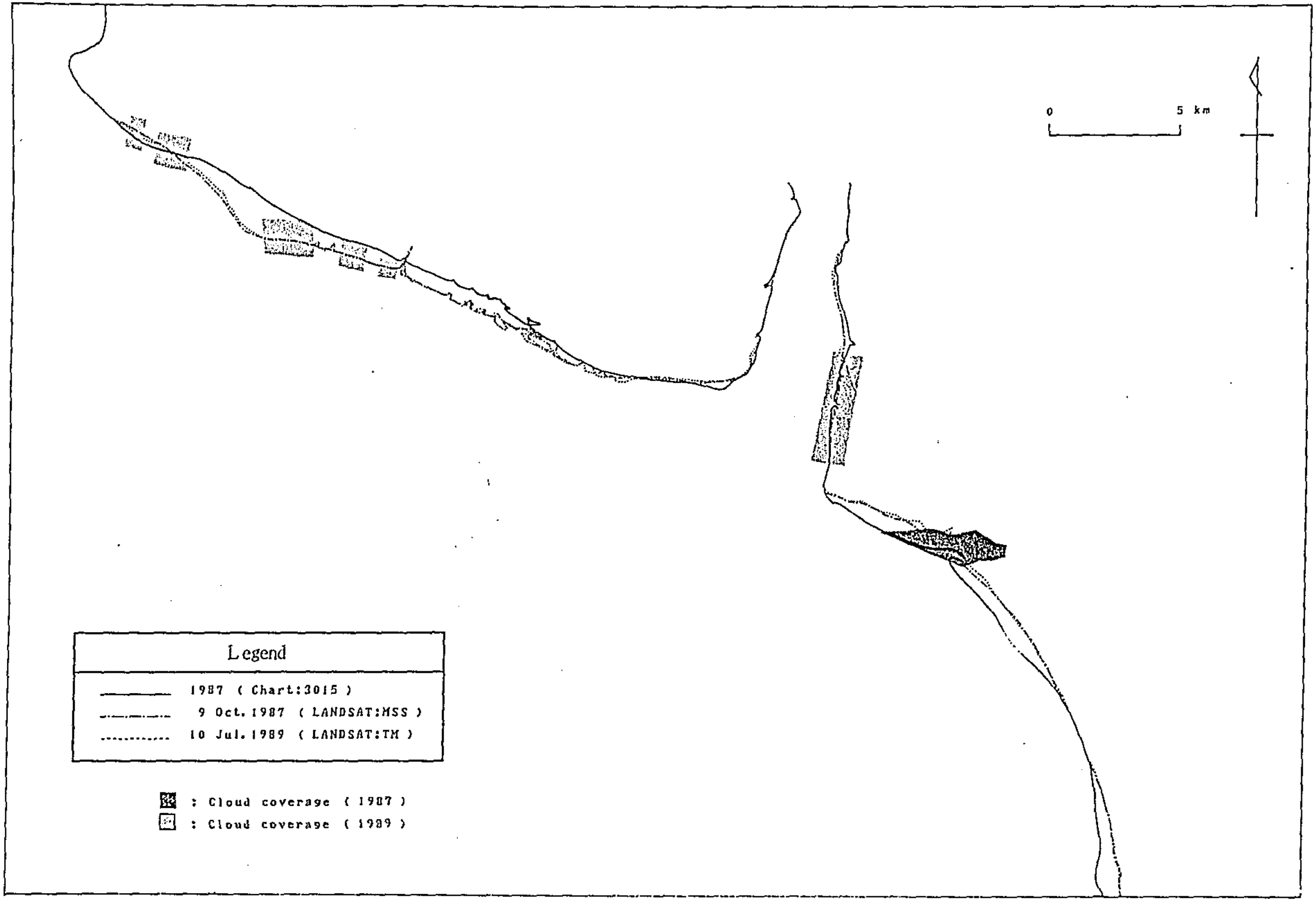


Fig. 5.5.1-7(3) Changes of Coastline(1987-1989)

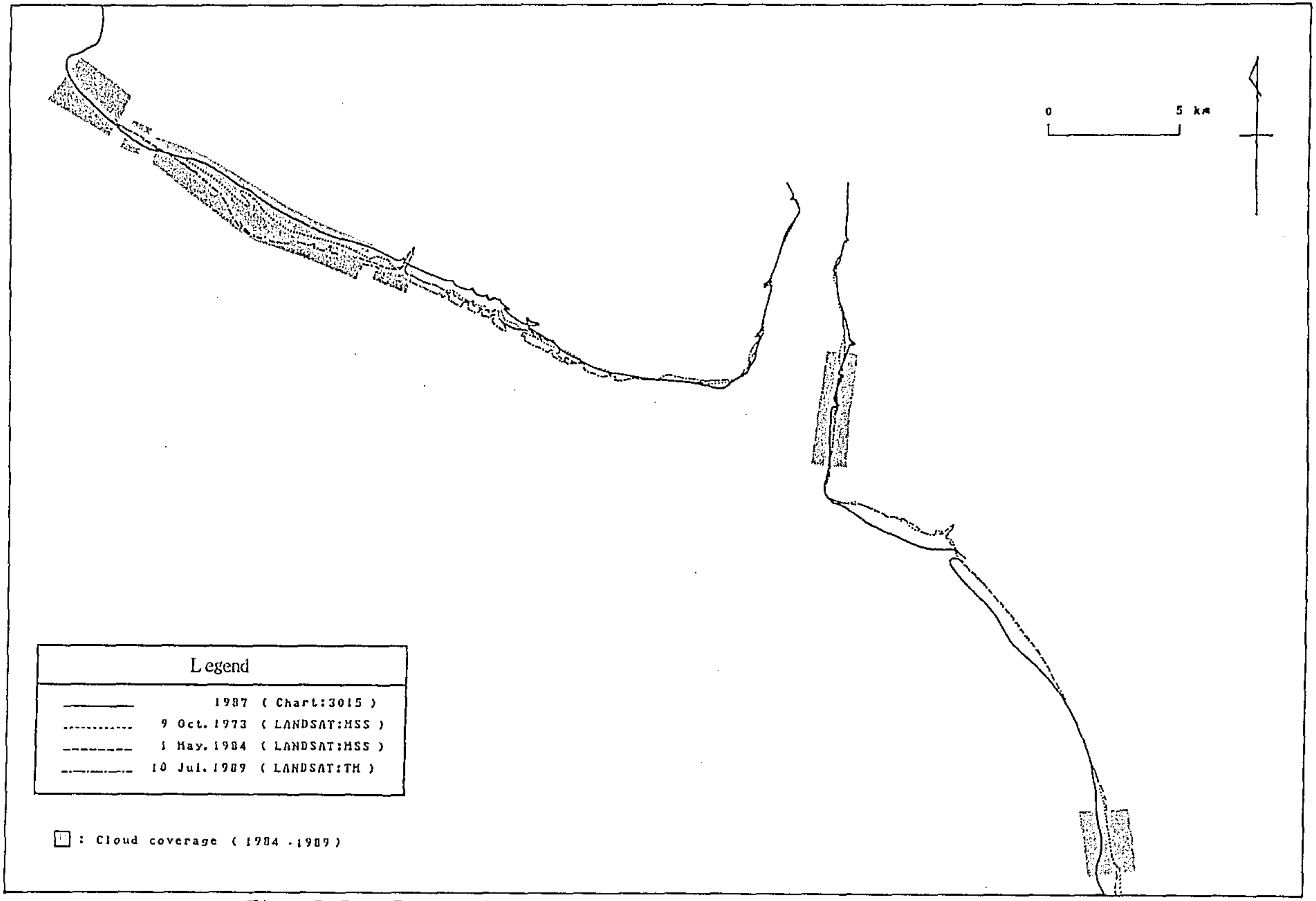


Fig. 5.5.1-7(4) Changes of Coastline(1973-1984-1989).

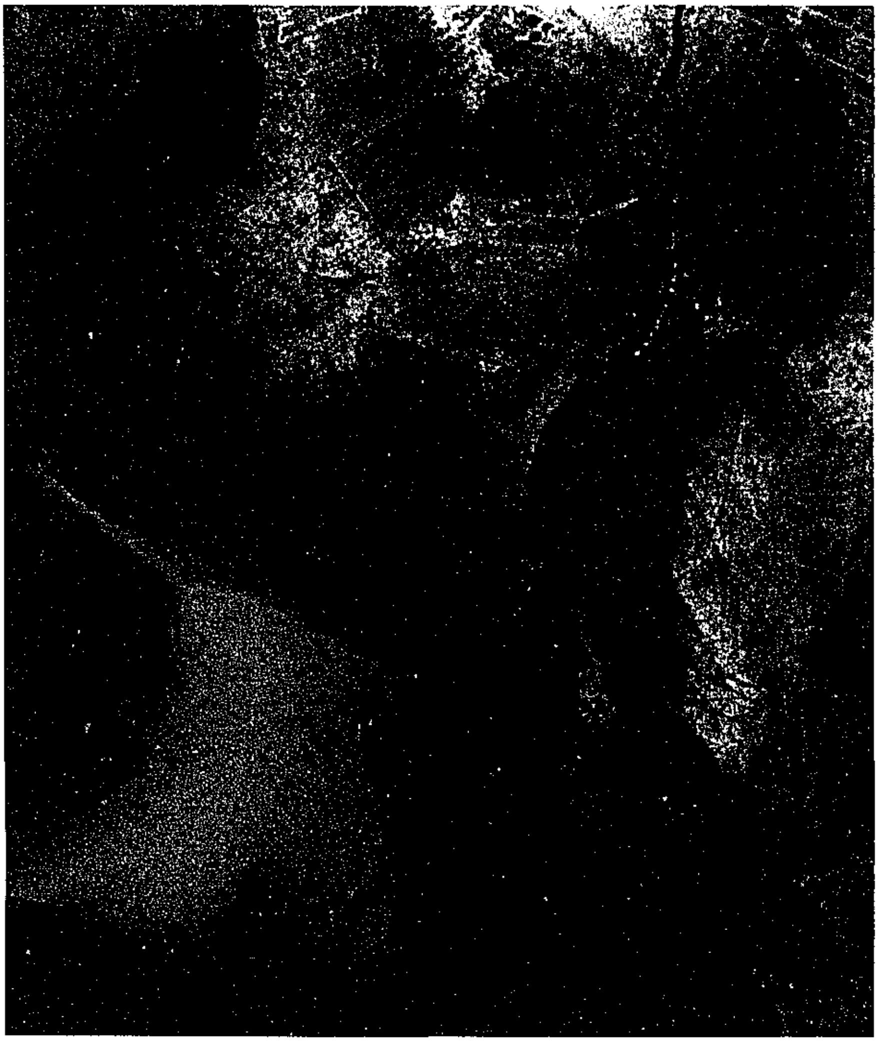


Fig. 5.5.1-7(5) False color composite image (10th Oct. 1973)

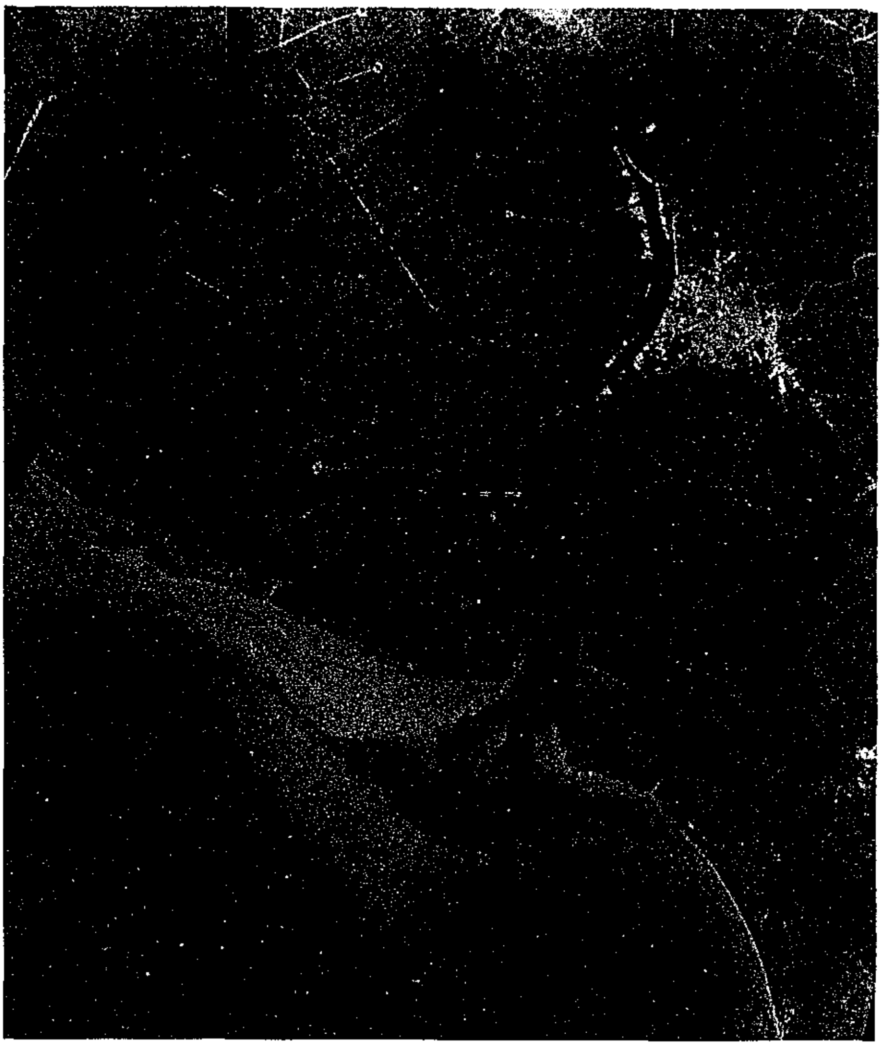


Fig. 5.5.1-7(6) False color composite image (21th Jun. 1988)

(2) Determination of turbidity patterns

(a) Results of Principal component analysis

Table5.5.1-3(1) shows the results of the principal component analysis (PCA) for the three MSS data, as required on 9th October, 1th May 1984 and 9th October 1987.
The principal component of each data are calculated from the CCT counts in the same water area in front of the Barito river.

Factor loading can be considered as correlations between principal components and original variables, the MSS CCT counts of the four bands in this case.
Then, the first principal components (PC1) in the MSS 3 stages data have positive correlation coefficients with all four MSS bands, in the other words, they heavily depend on the contributions of all four bands data.
And the PC1 are useful , because they contains maximum amount of the information of the calculating area in the sea.
Therefore, we may infer that the PC1 represents the entire amount of the energy backscattered from sea surface, which correlated with turbidity.
We may conclude that the PC1 reflects relative turbidity in each MSS data respectively, and that it is a scale factor of relative turbidity.

Table 5.5.1-3(2) shows the results of the PCA for the three TM data, as required on 18th April 1988, 21th July 1988 and 10th July 1989 .
It is noted that TM band6 data was not taken at the calculation of the PCA, because this thermal infrared band data yields no information about turbidity.
As well as the MSS data, we take the PC1s for the scale factor of relative turbidity.

Table 5.5.1-3(1) Results of Principal Component Analysis(PCA)

Date		9 Oct. 1973 (L-1 MSS)				1 May. 1984 (L-4 MSS)				9 Oct. 1987 (L-5 MSS)			
Bands		Band4	Band5	Band6	Band7	Band4	Band5	Band6	Band7	Band4	Band5	Band6	Band7
Statistic of CCT counts	Mean	34.56	31.31	20.83	4.92	14.56	13.82	4.72	5.61	34.57	28.32	19.75	10.34
	S.D.	4.19	7.09	6.00	1.66	1.87	2.95	2.50	1.63	2.12	2.26	3.19	1.39
	Max.	45	46	35	20	23	24	14	12	41	35	31	25
	Min.	26	20	11	0	5	3	0	2	26	19	11	6
Correlation Matrix for MSS Bands	Band4	1.00	0.93	0.91	0.73	1.00	0.67	0.67	0.29	1.00	0.36	0.02	-0.03
	Band5		1.00	0.94	0.76		1.00	0.81	0.23		1.00	0.58	0.24
	Band6			1.00	0.80			1.00	0.21			1.00	0.53
	Band7				1.00				1.00				1.00
Factor Loading of Principal Component	PC1	0.51	0.51	0.52	0.46	0.54	0.57	0.57	0.27	0.21	0.58	0.62	0.49
	PC2	-0.36	-0.30	-0.14	0.87	-0.04	-0.19	-0.22	0.96	0.81	0.32	-0.23	-0.44
	PC3	0.73	-0.19	-0.64	0.13	0.84	-0.38	-0.36	-0.12	0.49	-0.46	-0.28	0.69
	PC4	-0.29	0.78	-0.55	0.06	-0.01	-0.71	0.71	0.02	0.26	-0.59	0.70	-0.31
Cumulative Proportion	PC1	88.38 (%)				63.78 (%)				49.27 (%)			
	PC2	96.75				86.03				78.21			
	PC3	98.86				95.25				93.03			
	PC4	100.00				100.00				100.00			

Note 1 : S.D.... Standard deviation
Note 2 : PC1 ~ PC4... the first primary component ~ the fourth primary component

Table 5.5.1-3(2) Results of Principal Component Analysis(PCA)

Date		18 Apr. 1988 (L-5 TM)					
Bands		Band1	Band2	Band3	Band4	Band5	Band7
Statistic of CCT counts	Mean	70.22	29.99	35.01	0.94	8.10	4.20
	S.D.	2.83	3.61	8.69	0.70	1.94	1.29
	Max.	81	41	60	19	22	12
	Min.	62	23	20	7	0	0
Correlation Matrix for TM Bands	Band1	1.00	0.76	0.73	0.78	0.20	0.16
	Band2		1.00	0.96	0.75	-0.15	-0.10
	Band3			1.00	0.71	-0.23	-0.17
	Band4				1.00	0.22	0.15
	Band5					1.00	0.45
	Band7						1.00
Factor Loading of Principal Component	PC1	0.49	0.52	0.51	0.48	0.01	0.01
	PC2	0.18	-0.15	-0.22	0.19	0.68	0.64
	PC3	-0.06	0.08	0.08	-0.11	-0.63	0.76
	PC4	-0.58	-0.11	-0.08	0.80	-0.12	-0.01
	PC5	0.62	-0.43	-0.44	0.30	-0.37	-0.12
	PC6	-0.03	0.71	-0.70	0.00	-0.03	-0.02
Cumulative Proportion of Principal Component	PC1	56.03 (%)					
	PC2	83.50					
	PC3	92.86					
	PC4	96.52					
	PC5	99.45					
	PC6	100.00					

Date		21 Jul. 1988 (L-5 TM)					
Bands		Band1	Band2	Band3	Band4	Band5	Band7
Statistic of CCT counts	Mean	63.38	28.82	36.89	10.96	4.57	2.15
	S.D.	2.81	2.89	9.32	4.44	0.69	1.11
	Max.	72	36	57	26	30	13
	Min.	54	22	19	5	0	0
Correlation Matrix for TM Bands	Band1	1.00	0.81	0.64	0.56	-0.01	-0.01
	Band2			0.86	0.73	-0.11	-0.07
	Band3				0.91	-0.18	-0.13
	Band4					-0.15	-0.11
	Band5					1.00	0.05
	Band7						1.00
Factor Loading of Principal Component	PC1	0.45	0.52	0.52	0.49	-0.11	-0.07
	PC2	0.26	0.11	-0.05	-0.05	0.68	0.68
	PC3	-0.05	-0.02	0.01	0.10	-0.70	0.71
	PC4	0.68	0.22	-0.33	-0.56	-0.21	-0.15
	PC5	-0.50	0.68	0.22	-0.49	0.04	0.02
	PC6	0.15	-0.46	0.75	-0.45	0.02	0.02
Cumulative Proportion of Principal Component	PC1	55.05 (%)					
	PC2	72.64					
	PC3	88.42					
	PC4	96.58					
	PC5	99.18					
	PC6	100.00					

Date		10 Jun. 1989 (L-5 TM)					
Bands		Band1	Band2	Band3	Band4	Band5	Band7
Statistic of CCT counts	Mean	56.76	23.25	21.44	7.20	3.25	2.18
	S.D.	2.54	2.29	3.71	1.39	1.39	1.38
	Max.	67	31	34	14	10	7
	Min.	48	15	9	2	0	0
Correlation Matrix for TM Bands	Band1	1.00	0.79	0.56	0.60	0.31	0.30
	Band2		1.00	0.79	0.69	0.33	0.31
	Band3			1.00	0.68	0.24	0.21
	Band4				1.00	0.59	0.56
	Band5					1.00	0.55
	Band7						1.00
Factor Loading of Principal Component	PC1	0.42	0.47	0.42	0.48	0.33	0.31
	PC2	-0.27	-0.32	-0.38	0.12	0.57	0.59
	PC3	0.59	0.10	-0.46	-0.25	-0.40	0.47
	PC4	0.46	0.03	-0.37	-0.15	0.58	-0.54
	PC5	0.16	-0.38	-0.28	0.80	-0.27	-0.21
	PC6	-0.41	0.72	-0.51	0.20	-0.07	-0.09
Cumulative Proportion of Principal Component	PC1	59.53 (%)					
	PC2	79.43					
	PC3	87.25					
	PC4	94.63					
	PC5	98.00					
	PC6	100.00					

Note 1 : S.D.… Standard deviation

Note 2 : PC1 ～ PC6… the first primary component ～ the sixth primary component

(b) Analysis of Distribution of turbidity

We product the relative turbidity maps as Fig.5.5.1-8(1)-(6) by the six Landsat data, by calculating the PC1s of the entire water area and color-coding them.
In each color-coded map , the value of the relative turbidity (PC1) increase in accordance with the followings:

color / black - blue - green - yellow - orange - red - white

relative
turbidity/ none - slight - heavy - very heavy

Characteristics of the relative turbidity patterns at each six stages are summarized in Table 5.5.1-4.
A common feature of turbidity patterns is that coastal water is more turbid than river water in dry season, whereas river water is more turbid in rainy season.

Table 5.5.1-4(1)　Feature of turbidity pattern

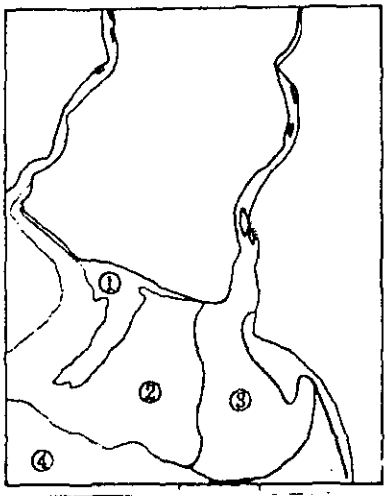
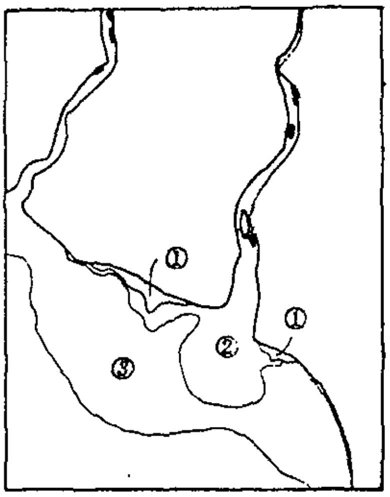
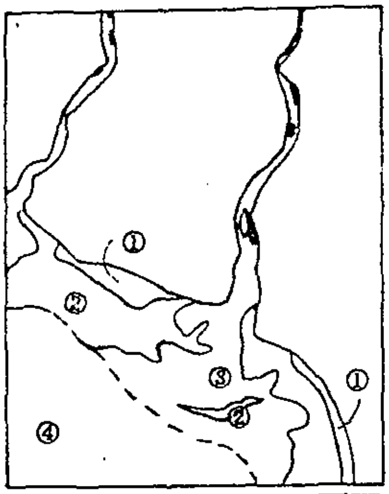
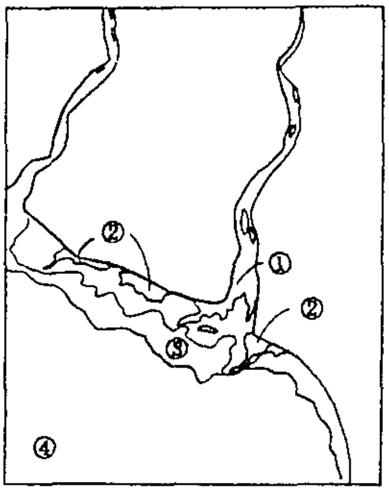
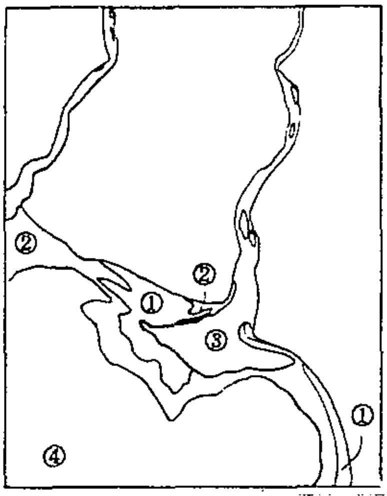
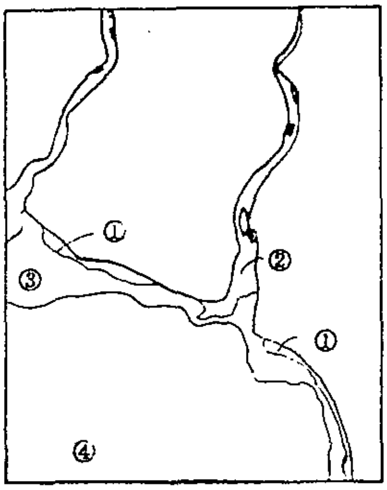
Landsat Data	*Season etc*	*Feature of Turbidity pattern*	
9 Oct. 1973 (*MSS*)	· dry · around low tide	There was a clear front between river water and coastal water. River water flowed in the direction of south. · relative turbidity ① very heavy ···· coastal water ② heavy ···· coastal water ③ slight ···· river water ④ ocean water	
1 May 1984 (*MSS*)	· rainy · higher low tide	River water flowed in the direction of south. River water showed spread pattern reaching the offing. · relative turbidity ① very heavy ···· coastal water ② heavy ···· river water ③ slight ···· ocean water	
9 Oct. 1987 (*MSS*)	· dry · ebb tide	River water flowed in the direction of south. · relative turbidity ① very heavy ···· coastal water ② heavy ···· coastal water ③ slight ···· river water ④ ocean water	

Table 5.5.1-4(2) Feature of turbidity pattern

Landsat Data	*Season etc*	*Feature of Turbidity pattern*	
18 *Apr. 1988* (*TM*)	· rainy · ebb tide	· There were clouds over the offing. · relative turbidity ① very heavy ···· river water ② very heavy ···· coastal water ③ heavy ···· coastal water ④ slight ···· ocean water	
21 Jun. 1988 (*TM*)	· end of rainy season · flood around high tide	There was a clear front between river water and coastal water. · relative turbidity ① very heavy ···· coastal water ② heavy ···· coastal water ③ slight ···· ocean water ④ slight ···· river water	
10 Jul. 1989 (*TM*)	· end of rainy season · flood around high tide	· There were clouds over the sea or hazy around the mouth of Barito river. · relative turbidity ① very heavy ···· coastal water ② heavy ···· river water ③ slight ···· coastal water ③ slight ···· ocean water	

Relative Turbidity (slight) ————————————> (heavy)

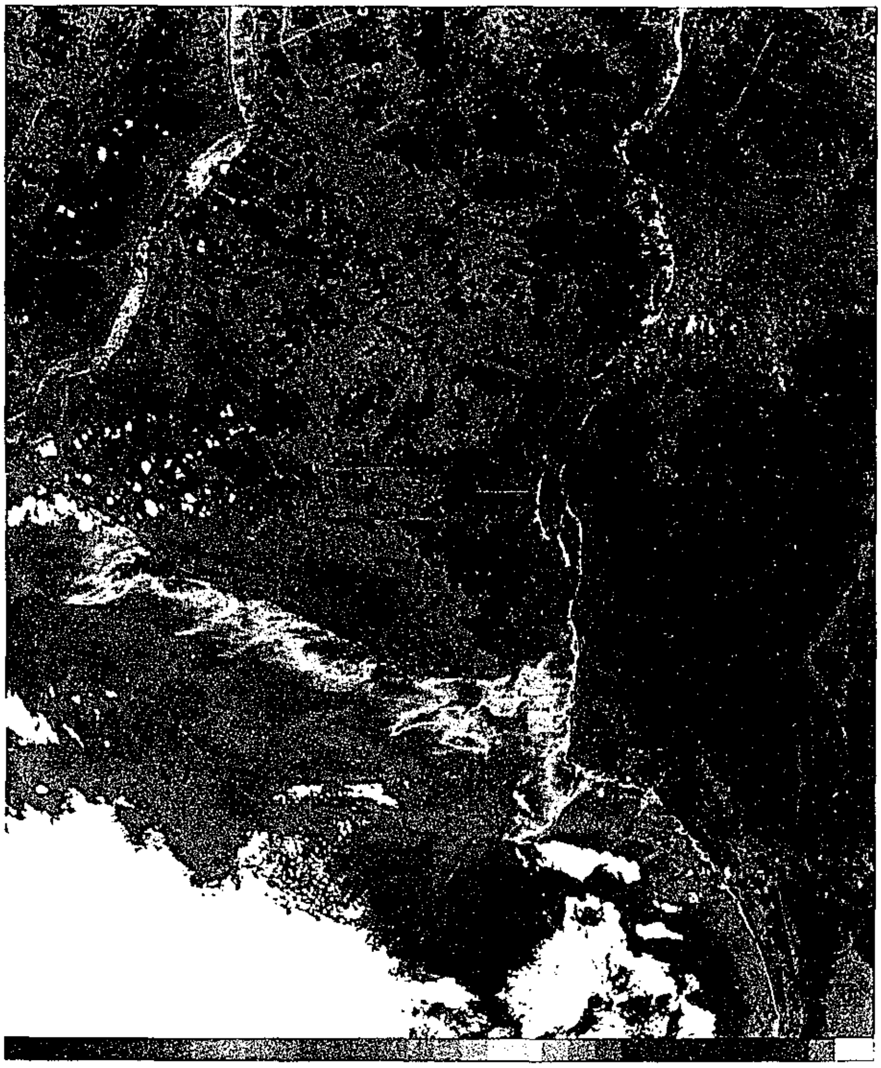
Fig. 5.5.1-8(1) Relative Turbidity Map (10th Oct. 1973)

Relative Turbidity (slight) ——————> (heavy)

Fig. 5.5.1-8(2) Relative Turbidity Map (1st May 1984)

Relative Turbidity (slight) ——————————> (heavy)

Fig. 5.5.1-8(3) Relative Turbidity Map (10th Oct. 1987)

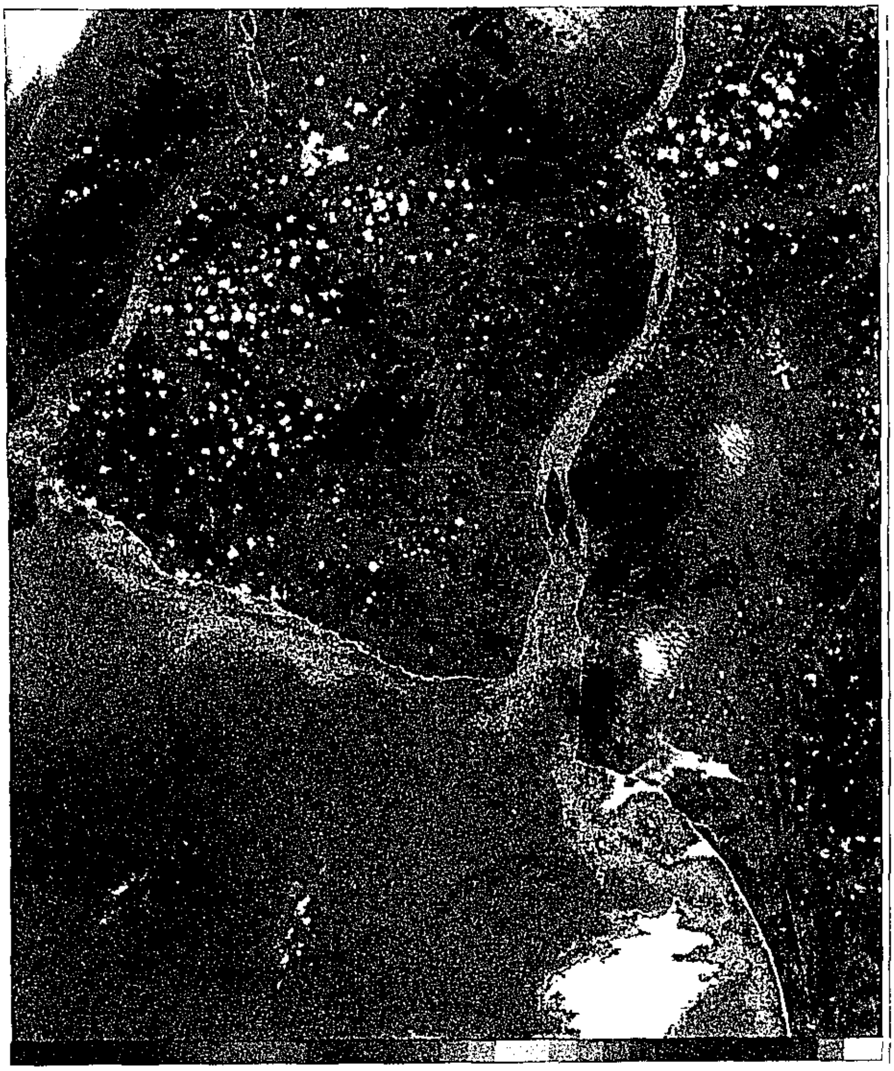


Relative Turbidity (slight) ————————————————> (heavy)

Fig. 5.5.1-8(4) Relative Turbidity Map (18th Apr. 1988)

Relative Turbidity (slight) ————————————> (heavy)

Fig. 5.5.1-8(5) Relative Turbidity Map (21th Jun. 1988)



Relative Turbidity (slight) ——————————> (heavy)

Fig. 5.5.1-8(6) Relative Turbidity Map (10th Jul. 1989)

(3) Analysis of temperature distribution

Fig. 5.5.1-9(1)-(3) show the relative temperature distribution pattern produced from the three TM data, on 4th April 1988, 21th June 1988 and 10th July 1989.
In these color-coded image, one color corresponds with a count of TM band6 CCT count.
Characteristics of temperature patterns of each image are summarized in Table 5.5.1-5

Table 5.5.1-5 Feature of Water temperature pattern

Landsat Data	*Season etc*	*Feature of Water temperature pattern*
18 *Apr. 1988* (*TM*)	· rainy · rainy · ebb tide	· There were clouds above the sea. · relative water temperature ① high ---- along the east coastline of the Barito river ② low ---- west part of coastal water
21 Jun. 1988 (*TM*)	· end of rainy season · flood around high tide	There was a clear front between river water and coastal water. · relative water temperature ① high ---- river water around the river mouth , and west part of ocean water ② low ---- coastal water along the coastline
10 Jul. 1989 (*TM*)	· end of rainy season · flood around high tide	It was hazed around the river mouth of Barito river, and thre showed lower temperature.

TM BAND6
CCT COUNT 120 125

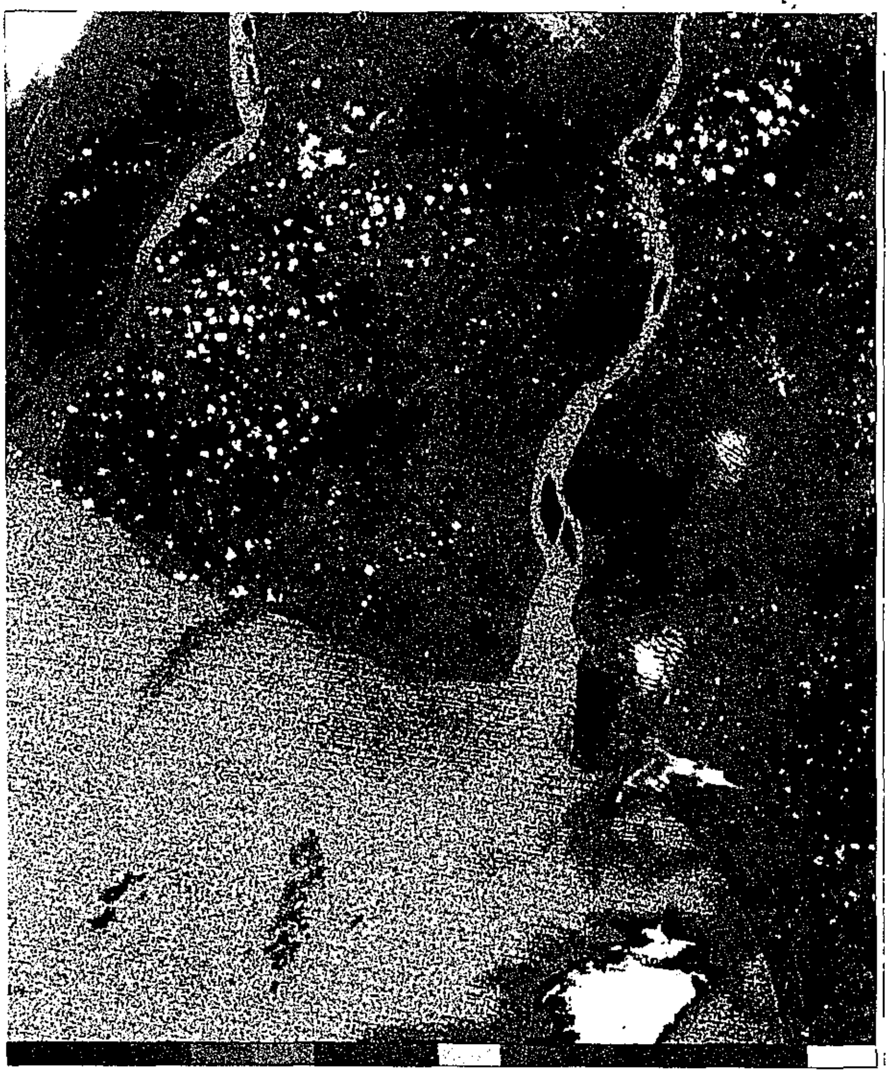
Relative Temperature (low) ——————————> (high)

Fig. 5.5.1-9(1) Relative Water temperature Map (18th Apr. 1988)

TM BAND6
CCT COUNT 132 135 140 143

Relative Temperature (low) ——————> (high)

Fig. 5.5.1-9(2) Relative Water temperature Map (21th Jun. 1988



Relative Temperature (low) ——————————> (high)

Fig. 5.5.1-9(3) Relative Water temperature Map (10th Jul. 1989)

(4) Analysis with Sea-Truth Data

On 10th July 1989, Landsat TM data was required approximately at 10:00 a.m. local time.
On the same day, water quality parameters, turbidity, suspended solids (SS) and water temperature were observed in the 12th Saline Wedge Survey.
These are available for estimating water parameters derived from Landsat digital data.
Then, we collect water quality observations in Table 5.5.1-6 from 10:00 to 12:00 a.m. from the -1m observation layer , in order to compare them with Landsat CCT counts.
The CCT counts in Table 5.5.1-6 are the mean value of nine pixel square surrounding the each predicted pixel that is located on the observation stations of the survey.
The observation stations, B, D, F and H are shown in Fig.5.5.1-9.

Table 5.5.1-6 Landsat data during Saline Wedge Survey (12th stage)

Date: 10th July, 1989 / Obs. Layer : -1m

St	Location	Water Quarity Parameter(observations)				Landsat TM CCT count							
		Item / Time	Turb. (ppm)	SS (mg/l)	Temp. (°C)	Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7	PC1
H	3°15′45″ S	10:00	.51	32.8	28.9	56	28	25	13	4	122	3	36
		11:00	61	25.9	28.8								
	114°33′11″ E	12:00	60	47.1	28.8								
F	3°21′54″ S	10:00	45	--	29.0	60	25	26	10	4	122	2	23
		11:00	34	9.1	29.4								
	114°31′11″ E	12:00	26	34.9	29.4								
D	3°31′ 8″ S	10:00	25	20.8	28.2	58	24	26	9	4	122	2	20
		11:00	38	20.8	28.4								
	114°29′43″ E	12:00	23	20.0	28.7								
B	3°35′18″ S	10:00	--	--	--	56	22	21	7	4	121	2	-4
		11:00	22	23.9	26.0								
	114°27′59″ E	12:00	16	16.2	26.6								

Note 1 : Turb.---Turbidity , Temp.---Water Temperature
Note 2 : PC1 ---The first primary component
Note 3 : The LANDSAT data obtained at 10:02 .

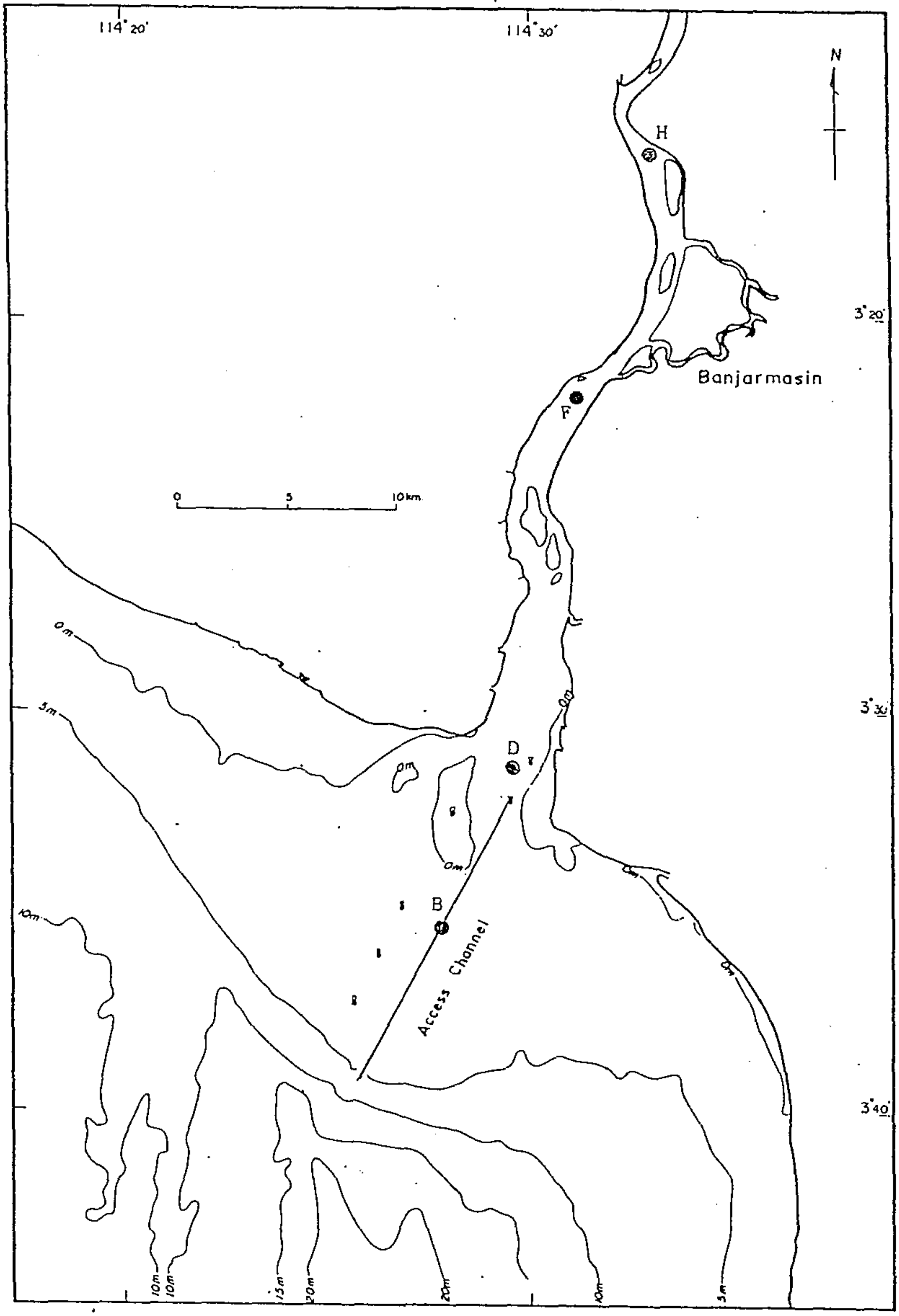


Fig. 5.5.1-10 Location of Observation Stations of Saline Wedge Survey (12th stage) on 10th July, 1989

(a) Turbidity

In Fig.5.5.1-11(1), we can see the changes of the turbidity observed at each station from 10:00 to 12:00 a.m. and the value of the first principal component (PC1) calculated from Landsat data required at 10:00 a.m. on 9th July, 1989.
The observed turbidity is decreasing with going down along the Barito river channel, from St.H to St.D, and at St.B that located in front of the river mouth is the minimum.
The count of PC1 varies in the similar manner.
Then observed turbidity at 10:00 a.m. and the PC1 counts are highly correlated as shown in Fig. 5.5.1-11(2).
It indicated that Landsat data has usefulness to investigate the water quality parameter, turbidity.
Turbidity variations measured at 10:00 a.m. ranged 25-51 ppm, and we can only get interpolated value in this significance.
Based on the linear regression model using the observation at 10:00 a.m., the predicted turbidity values are mapped in Fig. 5.5.1-11(3).
In this, the entire study area divided to 8 levels around 20-50 ppm.
It is noted that slight cloud coverage or haze appears at the east coastline of the mouth of Barito river, and that they looks like high turbid area.
Data indicates that turbid area which shows 20-50 ppm in turbidity are in the river channel and along coastline, but not offshore.
If we get the useful number of calibration data, ranged from low to high turbidity, we can develop the more reliable regression models for estimating turbidity from Landsat data.

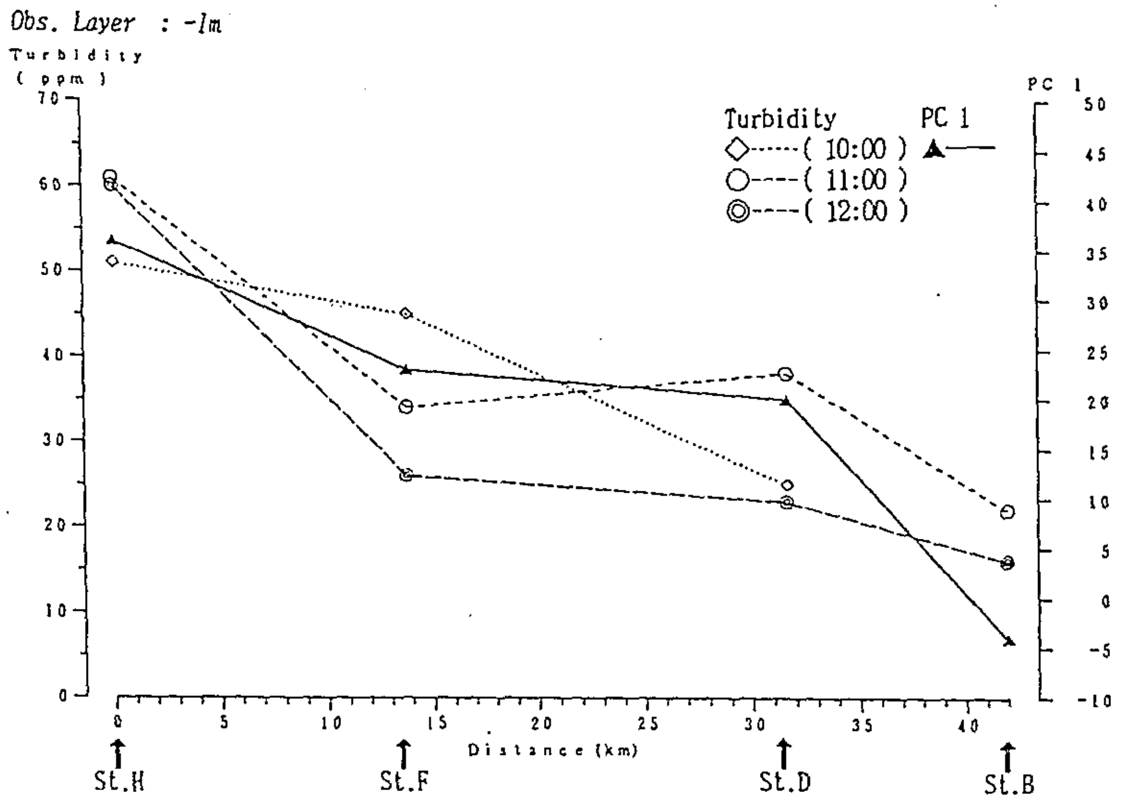


Fig. 5.5.1-11(1) Values of Turbidity and PC1 at each station

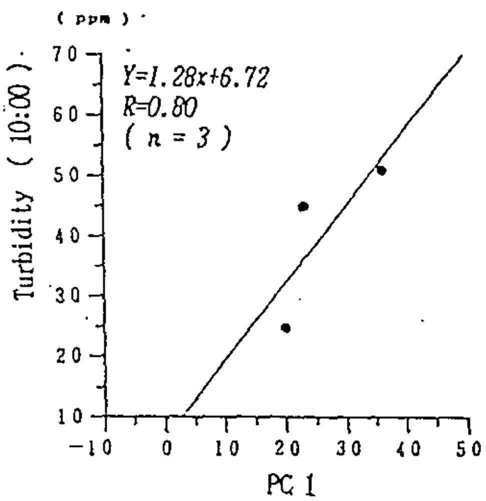
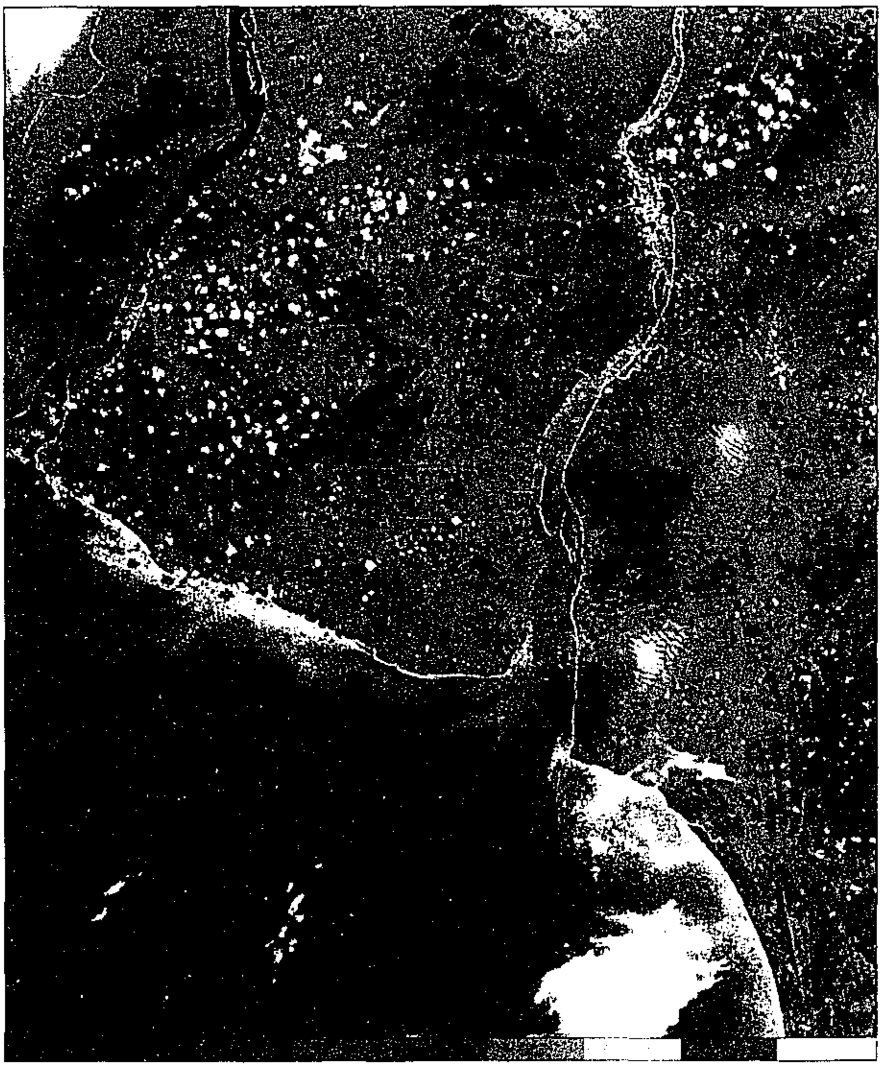


Fig. 5.5.1-11(2) Correlation between Turbidity(10:00) and PC1



Turbidity (%) ~10 ~20 ~30 ~40 ~50 ~60 ~70

Fig. 5.5.1-11(3) Predicted turbidity levels

(b) Suspended Solids(SS)

The observed SS values and the calculated PC1 counts at the stations are shown in Fig 5.5.1-12(1).
Except the data observed at 11:00 a.m., the value of SS and PC1 decreases with the distance from St.H.
When Landsat data was required, at 10:00 a.m., SS was measured at only two stations, as St.H and St.D.
In addition, the range of the observational SS data is small as 10(mg/l), so the regression model is not produced.

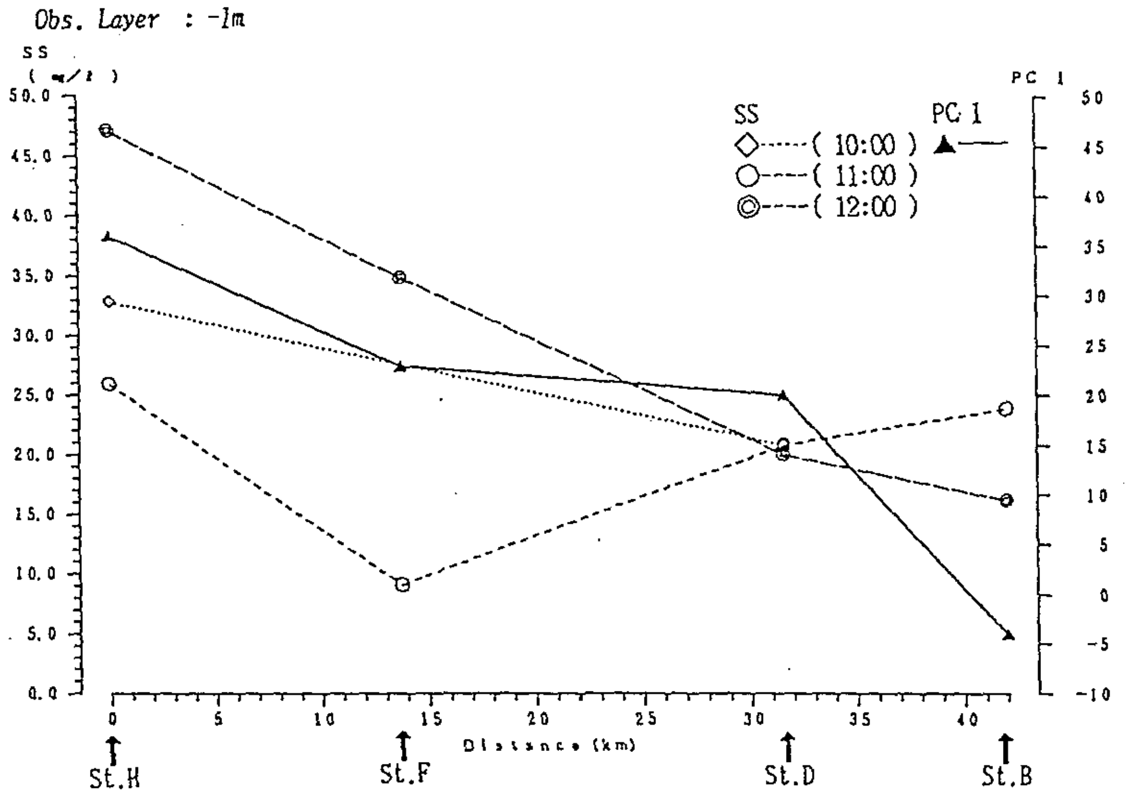


Fig. 5.5.1-12(1) Values of SS and PC1 at each station

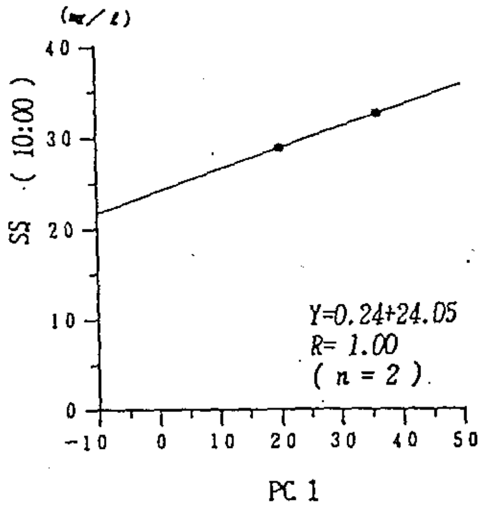


Fig. 5.5.1-12(2) Correlation between SS and PC1

(c) Water Temperature

The observed water temperature from the layer 1m under surface at each station are plotted and compared with TM band6 CCT counts in Fig 5.5.1-13(1).
Water surface temperature at 10:00 a.m., when Landsat data was required simultaneously, measured at three stations in the channel as St.H, St.F and St.D.
The observed temperature are ranged from 28.2 to 29.0 (℃), while the CCT counts are the same values 122.
These values are not enough to develop the regression models for estimating water temperature from TM band6 data.
We can only say that surface temperature is around 28-29 (℃) in the area of CCT count 122, and the area of lower CCT count than 122 has lower temperature ,the higher area has higher temperature than it, as shown in Fig. 5.5.1-13(3).
Data indicates that there is no relative difference in water temperature in the whole study area except the cloud or haze area which has low temperature, because CCT count 122 can be seen in all, such as river water, coastal water, and offshore water.

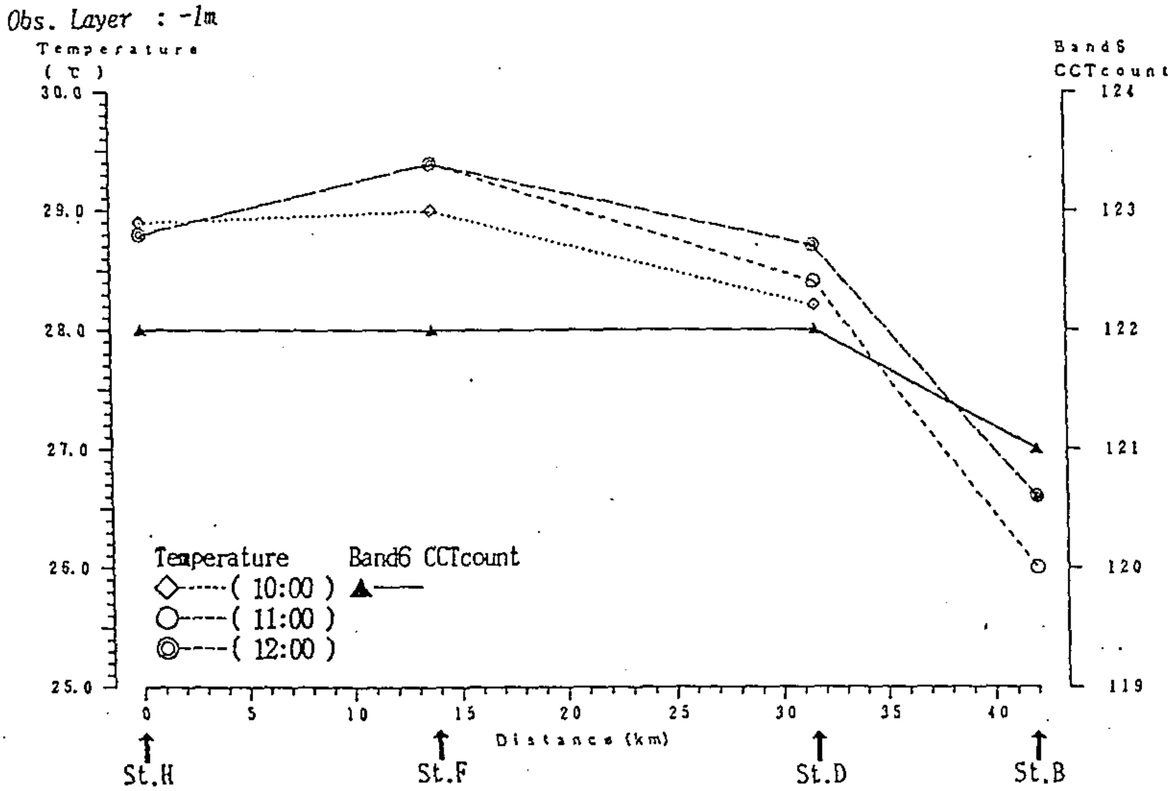


Fig. 5.5.1-13(1) Values of Watewr temperature and TM band6 CCT count

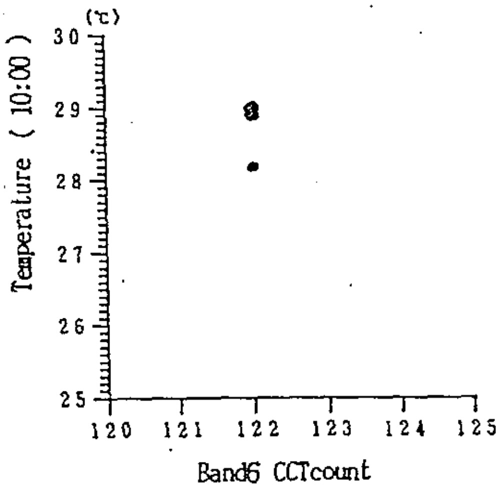


Fig. 5.5.1-13(2) Values of Water temperature and TM band 6 CCT count

Temperature (℃) lower 28~29 higher
TM BAND6 CCT COUNT 122

Fig. 5.5.1-13(3) Observed water temperature and Landsat band6 data

5.5.2 Long term and wide range change of submarine topography

An existed navigation chart (US. No.72060,1948) shows a rather simple fan shaped shoal as shown in Fig.5.5.2-1 reflecting possibly the topography in about 1948.
On the other hand, an Indonesian chart (No,17, 1983) depicts the recent condition from 1976 to 1982 as shown in Fig.5.5.2-2.
According to this figure, it can be seen that a dried up sand bar exyends from the west bank of the Barito river mouth toward the Access Channel like tongue and an isolated drying up sand bar exists on the east side flat. Both bars can not be found on the existed US chart, which suggests a possibility of the long term and wide range change of the submarine topography.

A comparison of depth contour among various charts was made and the result is illustrated in Fig. 5.5.2-3.
Assuming that each chart represents correct contour, it can be said that there has been a huge accumlation and development of bank around not only the Barito river mouth, but also at the Kapuas and Kahayan river mouths.
It is characteristics that the right hand banks of each river has proceeded much faster than the left hand banks.
However,the published year of the existed nautical charts which were referd does not always coincide with the year of survey. And also, the latest nautical chart does not always adopt the latest data.
Therefore, it is very difficult to make clear qualitative change of the coastal line by means of only existing nautical charts.
The condition of the change of the coastal line in recent several years(1973-1989) will be described in details in chapter 5.5.2 based on the Landsat data.

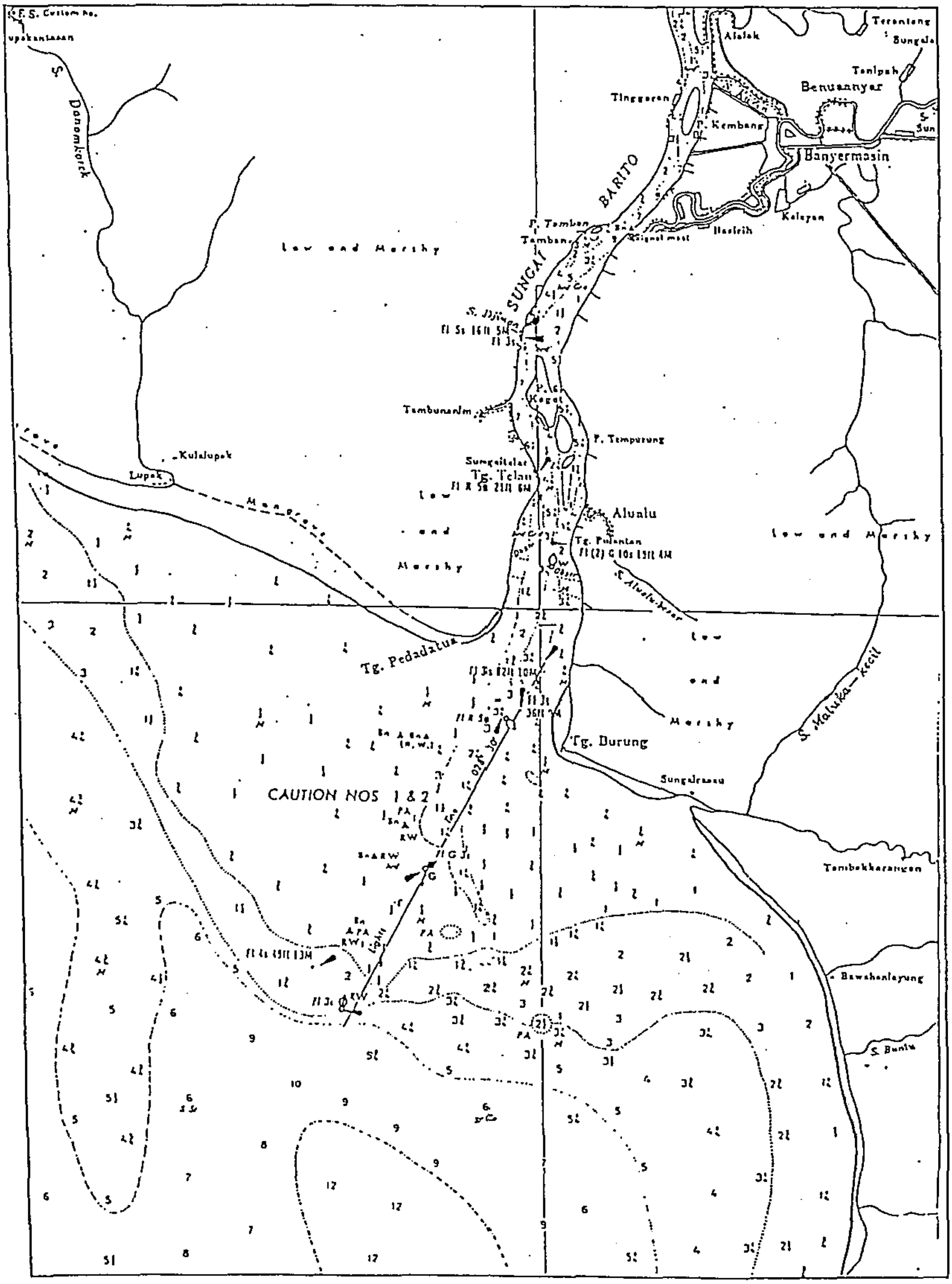


Fig. 5.5.2 -1   Narigation chart (US. No. 72060, 1984)

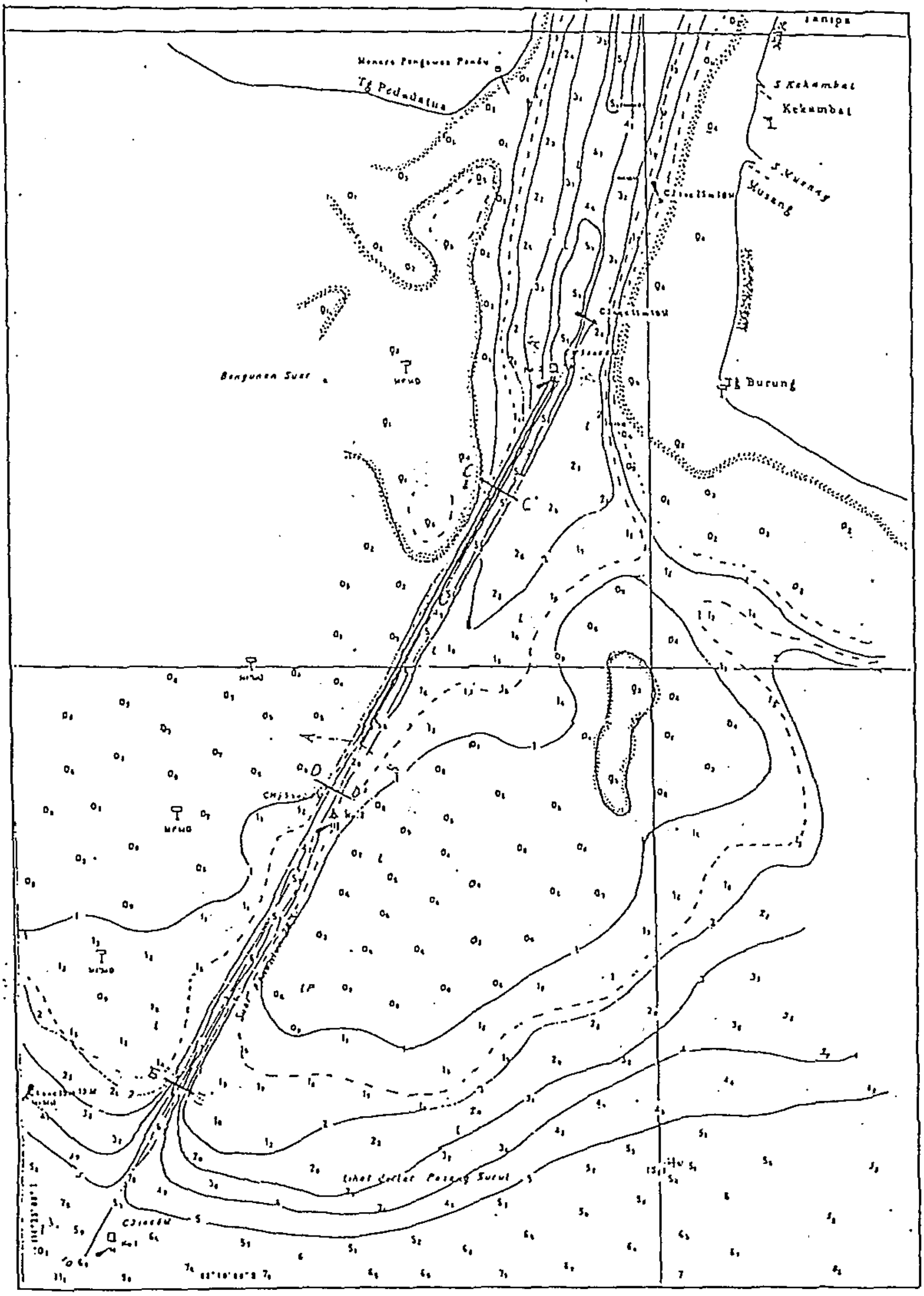


Fig 5.5.2 -2 Navigation Chart (Indonisia, No. 17, 1983)

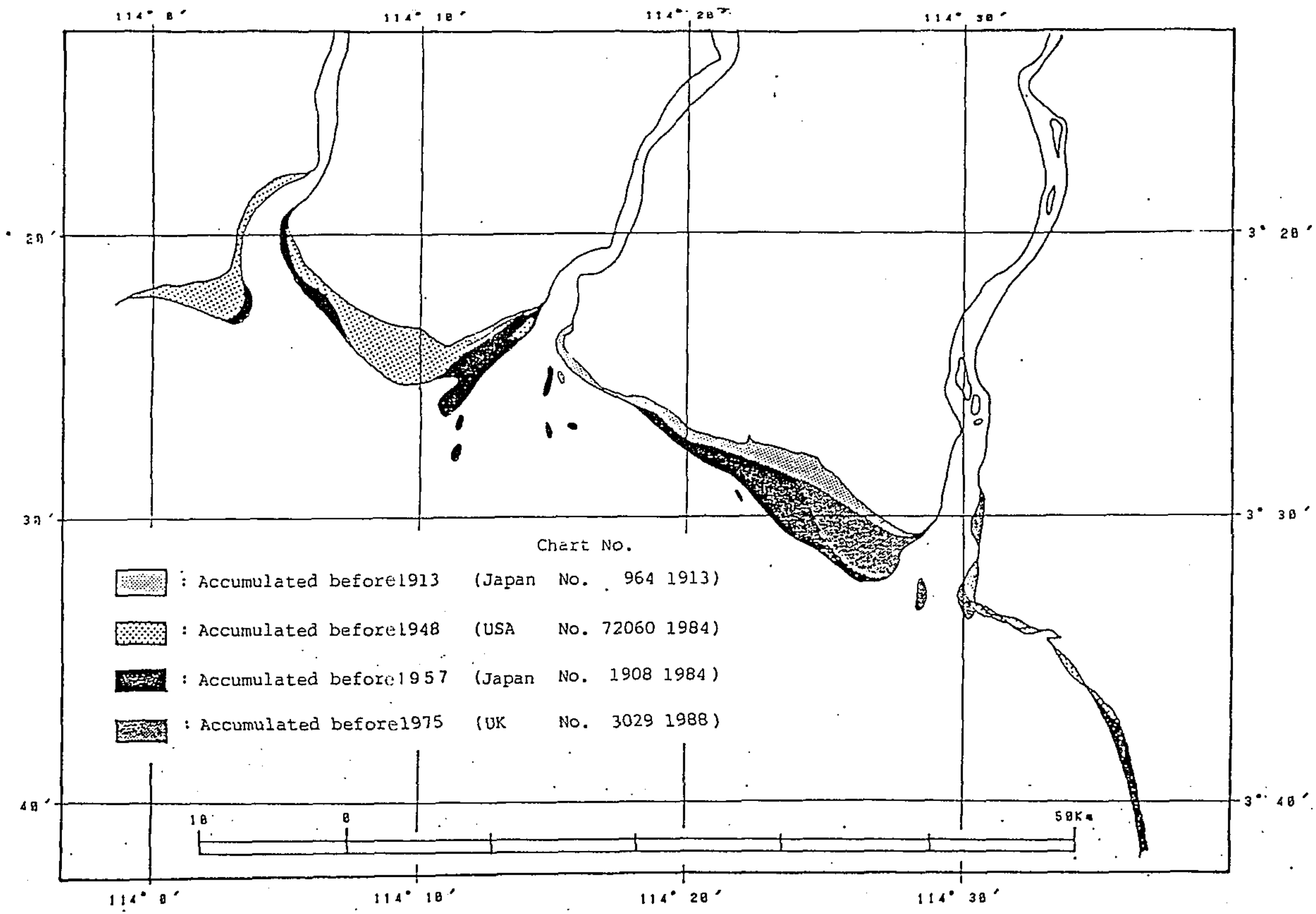


Fig. 5.5.2. -3 Change of the Topography, around the Barito River Mouth

5.5.3 Correlation of wind between Pilot Station and Banjarmasin Air Port

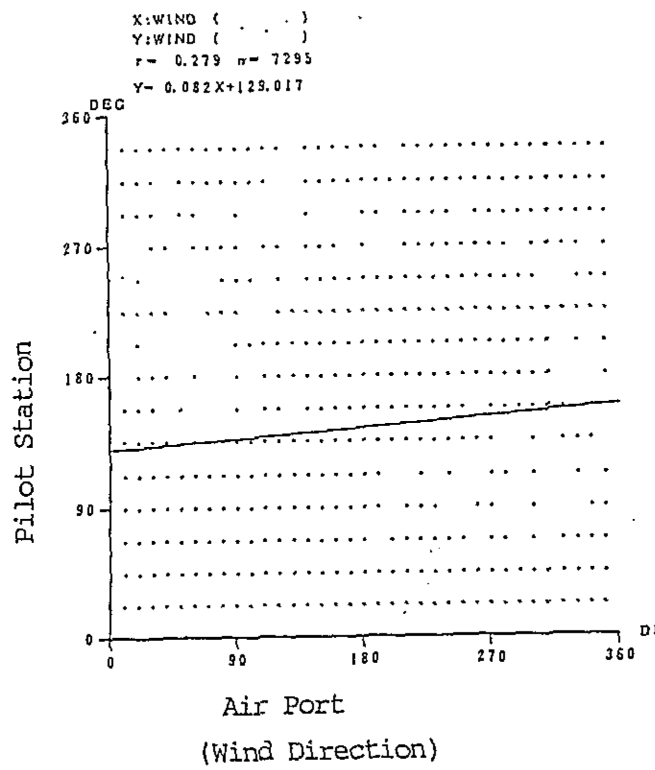
For the purpose of basic data submitting to the estimation of wave, correlation of wind direction and velocity between Pilot Station and Banjarmasin Air Port were examined by using the existing data observed in past time at the air port and the data observed at Pilot Station during natural condition survey.

Analysis duration are as under ;

- 1st Sep. 1988 - 31st July 1989

The results of analysis were shown in Fig. 5.5.3-1. According to the result, correlation of wind direction and velocity between Pilot Station and the air port were not seen well relation.

Duration: 1st Sep. 1988 - 31st July 1989



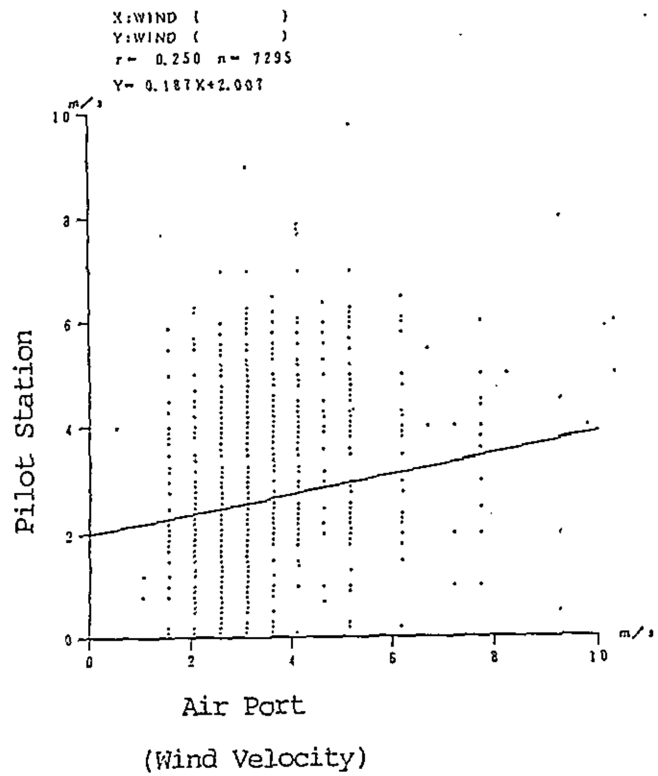


Fig. 5.5.3 − 1 Correlation of Wind Direction and Velocity between Pilot Station and Banjarmasin Air Port