

SURFACE SALINITIES IN THE STRAIT OF MALACCA

by

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SUMMARY

A continuous northwest-going current prevails in the Strait of Malacca throughout the year, except June and August, when the currents are very weak and sometimes reversed in the southern part.

The southern part of the Strait of Malacca is influenced by the currents. These currents transport low saline water into the Strait during the southwest monsoon and high saline water from the South China Sea during the northeast monsoon.

In the northern part, the rainfall is of greater importance for the variations of the surface salinity and a strong correlation between rainfall and surface salinities is found in this region.

It is unlikely that Indian Ocean water penetrates the South China Sea.

ZUSAMMENFASSUNG

Eine standige Stromung nach Nordwesten herrscht in der Malakka-Strasse wahrend des ganzen Jahres mit Ausnahme der Monate Juni und August, in denen die Stromungen im sudlichen Teil sehr schwach sind und zeitweilig entgegengesetzt verlaufen.

Der sudliche Tell der Malakka-Strasse steht unter dem Einfluss dieser Stromungen. Sie transportieren wahrend des Sudwest-Monsuns salzarmes Wasser in die Strasse und wahrend des Nordost-Monsuns salzreicherer aus der sudlichen China See.

Im nordlichen Teil ist der Niederschlag von grosserer Bedeutung fur die Schwankungen des Salzgehaltes an der Oberflache, und eine Korrelation zwischen dem Niederschlag und dem Salzgehalt ist in diesem Teil vorhanden.

Es ist unwahrscheinlich, dass Wasser aus dem Indischen Ozean in die Sudliche China See gelangt.

ICHTISAR

Arus kearah barat laut Jang terus menerus berlangsung sepanjang tahun di-selat Malaka, ketjuali dalam bulan Djuni dan Agustus, dalam waktu-mana arus itu sangat lemah dan kadang-kadang membalik dibagian selatan.

Bagian selatan selat Malaka dipengaruhi oleh arus. Arus ini memindahkan air jang berkadar garam rendah keselat itu selama musim barat daja dan air jang berkadar garam tinggi dari Laut Tiongkok Selatan selama musim timur laut.

Dibagian utara, turun hudjan adalah penting sekali bagi perubahan-perubahan kadar garam dipermukaan dan hubungan pengaruh-mempengaruhi jang kuat antara turun hudjan dan kadar garam dipermukaan terdapat dibagian ini.

Rupa-rupanja tidak mungkin, bahwa air lautan Hindia meresap ke-Laut Tiongkok Selatan.

As is known, the production of fish depends mainly on the availability of food which, in turn, depends on the production of phytoplankton, because the latter forms the basic product in the cycle of organic matter. Physical and chemical factors which favour this production are to be found in the Strait of Malacca. The energy for the photosynthetic process is sufficient as everywhere in tropical waters. The nutrient salts, phosphates and nitrates, which form a limiting factor in the phytoplankton production, seem to be sufficient too, because the Strait has influx of considerable fresh water containing nutrients from the land. The southern part of the Strait of Malacca is shallow, so that the sinking detritus containing organic matter which is regenerated at the bottom, could be distributed again into the whole water column by vertical mixing. According to K. M. WEEL'S observations (1923), there is a great difference in salinity between the bottom layers and surface layers in the northern section of the Strait throughout the year, except for a few weeks during or about August, wherein the salinity of the surface layer is about the same as that of the bottom layer. The data concerning the currents in the Strait of Malacca, show a continuous northwest-going current throughout the year, except in June and August, during which the water movements are very weak and sometimes reversed in the southern part. North of One Fathom Bank (about lat. 3° N.), the transport of less saline water in a northwesterly direction causes an opposite current in the deeper layers. This bottom current ascends when reaching the slope of the One Fathom Bank, and passes over into the surface current. This means that the nutrients from the bottom are distributed again into the whole water column.

These are the reasons that the Strait of Malacca is assumed to have a high potential production of fish.

The movements of watermasses with different salinities may be expected to play an important role on the migration of fish. For that reason, the author presents this paper, which could be used in fisheries hydrography.

The present paper is based on data of the years 1949-1954, consisting of 33.808 observations, which were collected for the Institute of Marine Research at Djakarta with the cooperation of Captains and Officers of several shipping companies, which operate regularly in the Strait of Malacca.

For the methods of collecting data, of analyzing samples, and of plotting them on the charts, the author refers to the previous papers of P. CH. VEEN (1951 and 1953) and E. SOERIAATMADJA (1956) as these

methods have remained exactly the same, so that a redescription is considered unnecessary here.

The area surveyed is the whole Strait of Malacca situated between Sumatra and the Malay peninsula, including its southern and northern entrances. The southern entrance is formed by the island group with several small passages South of Singapore, and the wide northern entrance is defined by a line connecting the north point of Sumatra with the island Lantar near the west coast of Malacca. The bottom of the Strait of Malacca shows a gradual slope from the coasts of East Sumatra and West Malacca to the centre of the Strait and can be divided into two parts by a threshold near the One Fathom Bank, from which place the bottom shows an increase in depth towards the Indian Ocean and towards the South China Sea. The increase towards the Indian Ocean is much greater than that towards the South China Sea.

The salinity data by months were averaged for each 20'-square, plotted on the chart, and the isohalines drawn with intervals of 0.5‰. The solid lines illustrate the even numbers, while the dotted lines the odd numbers of the salinities, Each chart is provided with an insert, on which the directions of the surface currents, according to the Atlas surface currents of the U.S. Navy Hydrographic Office, were drawn for the same month.

To gain a better insight into the annual variations of the surface salinities and their annual means, in the centre of the northern, middle and southern parts of the Strait of Malacca, Fig. 1 was prepared. The graphs are based on the average of the salinity values for each month. The solid lines represent the northern part between lats. 3° 40' N. and 5° N., the dotted lines represent the middle part just north of One Fathom Bank, while the cross lines represent the southern part of the Strait of Malacca.

The salinity in the northern part shows two maxima and two minima. The maximum in August with a salinity of 32.0‰ is higher than that in February. The minimum in December with a salinity of 30.6‰ is lower than that in May. Compared with the salinity in the northern part, the salinity in the middle part shows a much lower value in all months. The maximum of 31.2‰ occurs in July, the minimum of 28.9‰ in December, corresponding with that in the northern part. A secondary minimum of 30.1‰ is to be noted in May, also corresponding with a minimum in the northern part. Compared with the first two graphs, that of the southern part shows a quite different picture. There is only one maximum of 30.8‰ occurring in March and one minimum of 28.3‰ occurring in October. Both extreme values occur earlier than in the middle

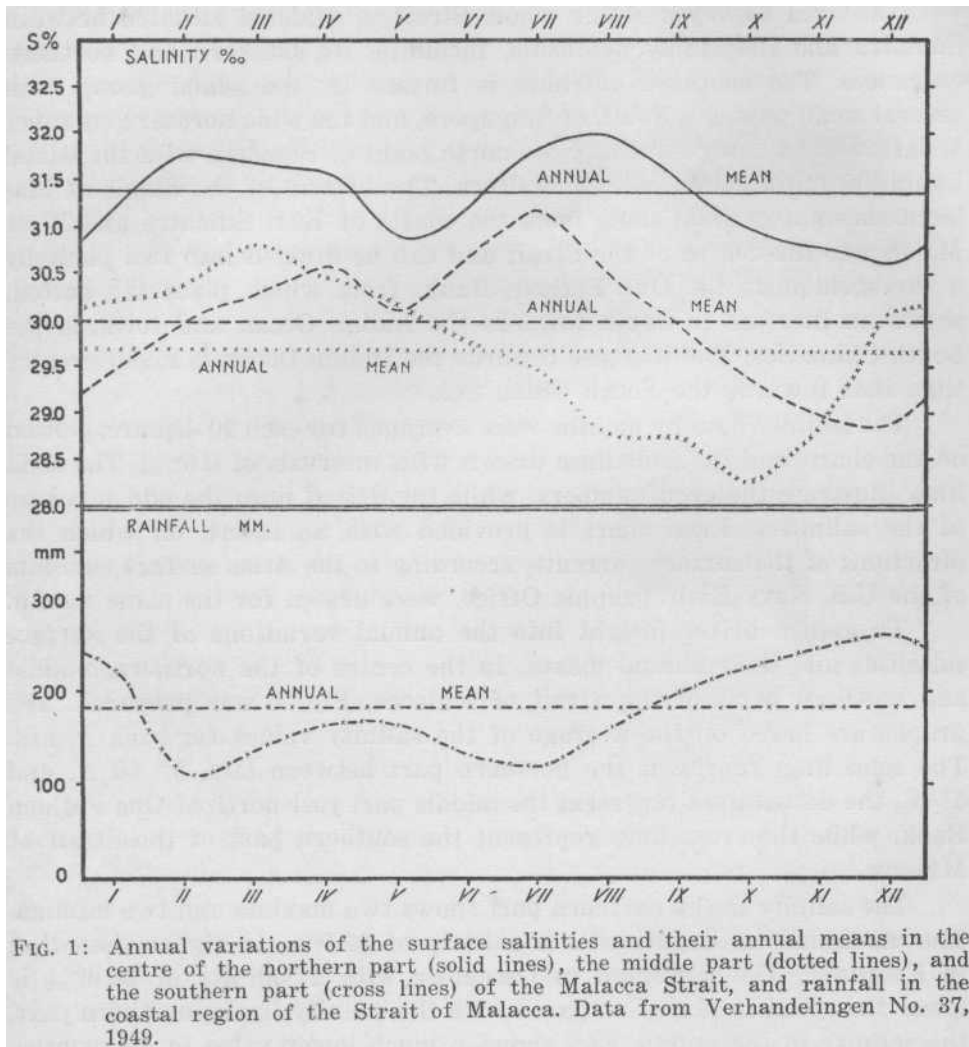


FIG. 1: Annual variations of the surface salinities and their annual means in the centre of the northern part (solid lines), the middle part (dotted lines), and the southern part (cross lines) of the Malacca Strait, and rainfall in the coastal region of the Strait of Malacca. Data from Verhandelingen No. 37, 1949.

part. Describing the salinity pattern in the Strait of Singapore, THAM AH KOW (1953) found in 1948-1949 two maxima, one during March-April, the other during November, and two minima, one during December-January, the other July-August. For the region off the bay of Djakarta in the Java Sea, the writer found, in the period 1949-1955 two maxima, one during May, the other during October-November, and two minima, one during January-February, the other during July, while for the region off the north coast of Madura there was only one maximum during September, and one minimum during April.

The annual range in salinity in the northern, middle and southern parts of the Strait of Malacca are $1.4^{\circ}/_{\text{oo}}$, $2.3^{\circ}/_{\text{oo}}$ and $2.5^{\circ}/_{\text{oo}}$ respectively, while the absolute salinity minimum is $2.3^{\circ}/_{\text{oo}}$ lower in the southern part than that in the northern part.

It is interesting to compare the salinity data of the northern part of the Malacca Strait with the data of rainfall in the coastal area of the Malacca Strait (Fig. 1). A strong correlation is noted between the rainfall and surface salinities in this region.

Figures 2 and 3 were prepared to gain a better insight into the surface salinity distributions in the Strait of Malacca. Fig. 3 represents isopleths of the surface salinity of the region investigated according to the line extending across the Strait from long. 97° E. and lat. $5^{\circ} 40'$ N. towards long. $105^{\circ} 10'$ E. and lat. $0^{\circ} 30'$ N. as shown in Fig. 2.

In studying the twelve charts and the figures, some remarkable facts are noted.

According to the Malacca Strait Pilot (1946), there is a current in a general northwesterly direction through the central part of the Strait throughout the year. As a consequence, the water from the Strait emerges into the Indian Ocean in a westerly or northwesterly direction. In the full southwest monsoon period of June-July, a current flows along the eastern part of the Andaman Sea along the west coast of the Malay peninsula southward, but turns to the west before entering the Strait of Malacca. This current meets the westgoing current, emerging from the Malacca Strait between about lats. 6° N., penetrating the Indian Ocean.

During the northeast monsoon period of October-April, a southgoing current prevails in the South China Sea, adding water over $32.0^{\circ}/_{\text{oo}}$ from the South China Sea through the Gaspar and Karimata Straits into the Java Sea. This southgoing current causes a branch, which rounds the Malay peninsula in the south, entering the Malacca Strait. The branch is demonstrated by an invasion of the South China Sea water into the Strait of Malacca, replacing the low saline water in the southern part of the Strait. The

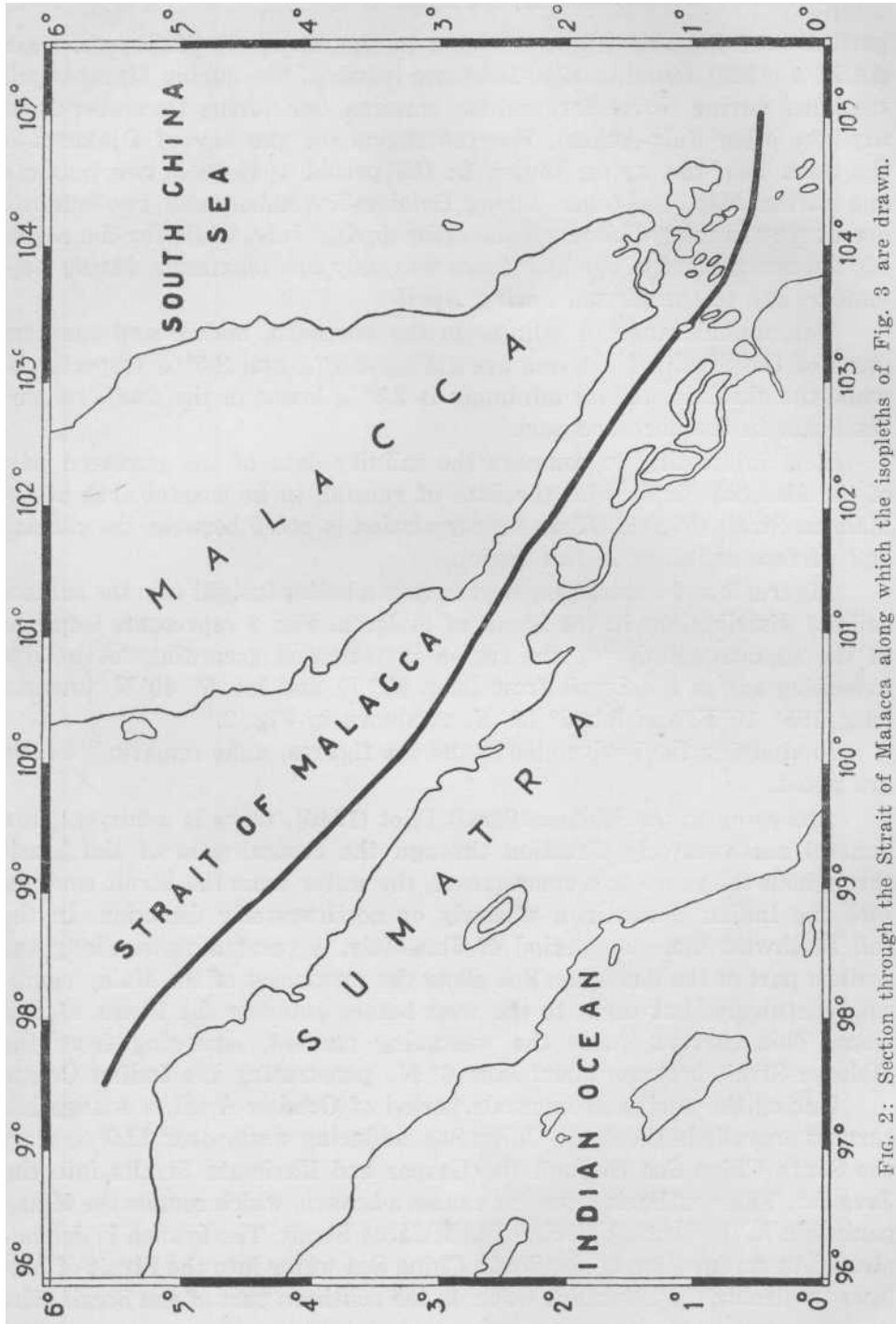


Fig. 2: Section through the Strait of Malacca along which the isopleths of Fig. 3 are drawn.

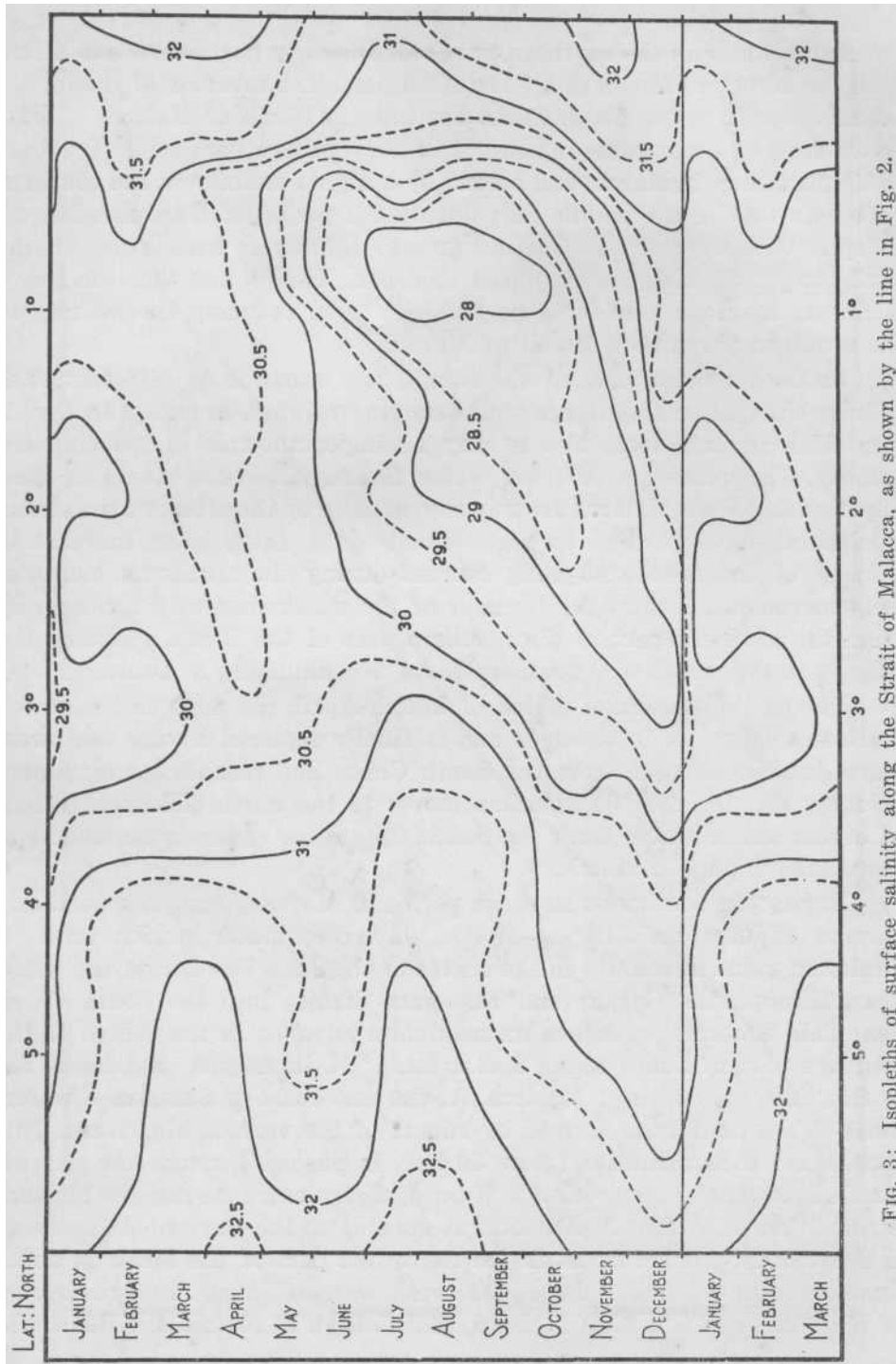


Fig. 3: Isopleths of surface salinity along the Strait of Malacca, as shown by the line in Fig. 2.

low saline water in the southern part moves slowly northward and mixes with the higher salinities in the northern part. The invasion of the higher saline water from the South China Sea into the Strait of Malacca is illustrated first by an increase in salinity in the southern part (after October) to its maximum in March, and second by a higher salinity in the southern part than that in the middle part during the period of December-March. In spite of heavy rainfall, an increase in salinity is maintained in the southern part during the northeast monsoon. This means that the heavy northeast monsoon rain is of no importance in reducing the salinity in the southern part of the Strait of Malacca.

In the northern part of the Strait, the situation is different. The salinity changes in accordance with changing rainfall, as shown in Fig. 1. The tidal currents seem also to play an important role in reducing the salinity. The quantities of fresh water flowing from the rivers of East Sumatra and West Malacca are mixed gradually by the effect of the strong tidal currents. According to the available data, there is an increase in velocity of the northwest-going current during the northeast monsoon. This current accelerates the transfer of the watermass with low salinity from the southern part to the northern part of the Strait, reducing the salinity in the middle and northern parts to a minimum in December.

During the transition period of March-April, the northeast monsoon gradually decreases in strength and is finally replaced by the southwest monsoon. The current from the South China Sea reaches its maximum velocity, and the 30.5‰ isohaline moves to the north. The penetration of higher saline water from the South China Sea causes a maximum in the northern part in March.

During the southwest monsoon period of May-September, a northerly current adduces the 31.0‰ - 32.0‰ Java Sea water, which forms a minimum value in salinity in the centre of the Java Sea during the whole year, through the Gaspar and Karimata Straits into the South China Sea. This watermass reaches its maximum advance in the centre of the southern part of South China Sea at lat. 1° N. in August, and seems not to flow into the Strait of Malacca. At the east coast of Sumatra a watermass of low salinity is formed by runoff of the various big rivers. This watermass with salinities below 30.0‰ is pushed through the narrow straits between the many islands of the southern entrance into the Malacca Strait in a northwesterly direction. According to the Current Atlas, there is a southeast-going current in the narrowest part of the Strait in about June and August. This means that fresh water flowing from the rivers of East Sumatra and West Malacca, south of lat. 3° N., reduces the south-

east-going current. The low saline watermasses, flowing from the south-east and from the northwest, meet in the southern entrance of the Strait and form a front between longs. 104° E. - 105° E. and lats. 0° - 1° N. during June-August. From then onwards, the front thus formed slowly moves northwestward, mixes with watermasses in the inner part of the Strait, emerging further into the Indian Ocean. It is probable that this could be one of the important factors in reducing the salinity in the southern part, in spite of less rain. The decrease in salinity starts in the coastal region of East Sumatra, advancing gradually to the southpoint of Malay peninsula. This could be attributed to the greater landdrainage from the rivers of East Sumatra than that from the rivers of West Malacca.

In the northern and central parts of the Malacca Strait, a decrease in salinity is noted in May. This is in accordance with the slight increase in rainfall after February. Besides, the high velocity of the northwest-going current during March-April, accelerates the transfer of low saline water from the inner part of the Strait into the northern part, which water also helps in lowering the salinity in the latter region to a minimum in May. A sudden increase in salinity starting after May, to the maximum in August, after which it decreases again to a minimum in December, also coincides with the slight drop in rainfall from May to August, after which it increases to a maximum in December. Whilst discussing the Malacca Strait, K.M. WEEL (1923) stated that, in August, the salinities in the Strait of Malacca gradually increased from South to North and that this was a consequence of the unimportant discharge of fresh water from the rivers into the Strait, of the weak northwest-going current, and of the strong tidal streams. This increase in salinity in the Malacca Strait from South to North starting in June and ending in September, is also noted by the writer.

The lowest salinities in the northern part of the Strait of Malacca are found along the Malacca shore throughout the year, and increase towards the east coast of Sumatra. This phenomenon seems to be caused by the northwest-going current being stronger along the west coast of Malacca than that along the east coast of Sumatra. This would push the low saline watermass from the inner part of the Strait more towards the west coast of Malacca.

The 30.5‰ isohaline, as seen in the isopleths between lats. 3° N. - 4° N., separates two watermasses. The one, which occupies the middle and northern parts of the Malacca Strait has two salinity maxima and

two salinity minima, while the other, covering the southern part of the Strait, has only one salinity maximum and one salinity minimum.

The isopleths show two types of northwesterly watermovements in the Strait of Malacca, one as a result of the northeast monsoon transporting high saline water from the South China Sea into the Strait, the other as a result of the southwest monsoon transporting low saline water from the coastal region of East Sumatra into the Strait.

ACKNOWLEDGMENTS

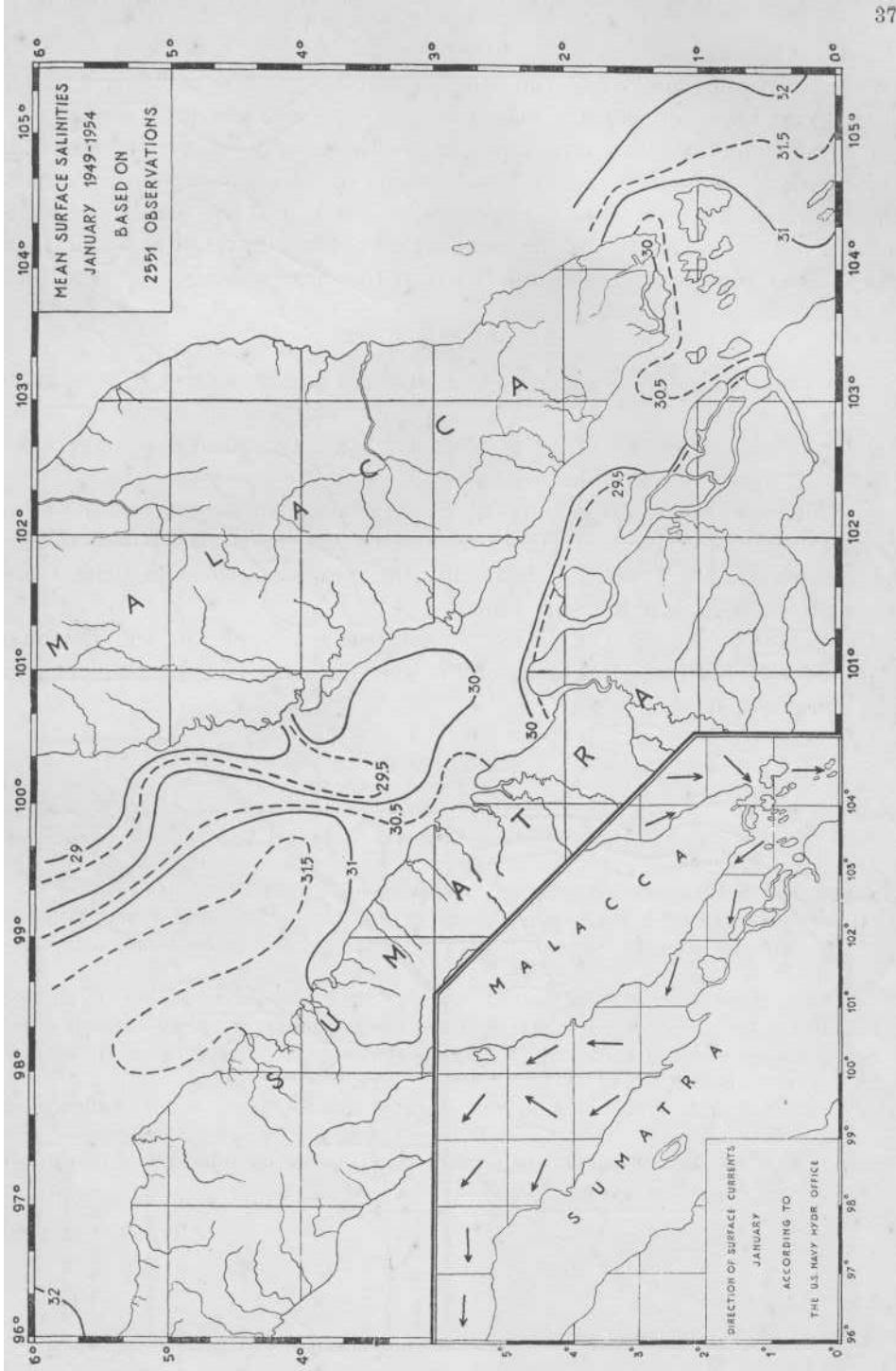
Acknowledgment is given to the Officers of the several private navigation companies and to the government Navigation Services which operate regularly in the Strait of Malacca, for their voluntary cooperation in taking the water samples.

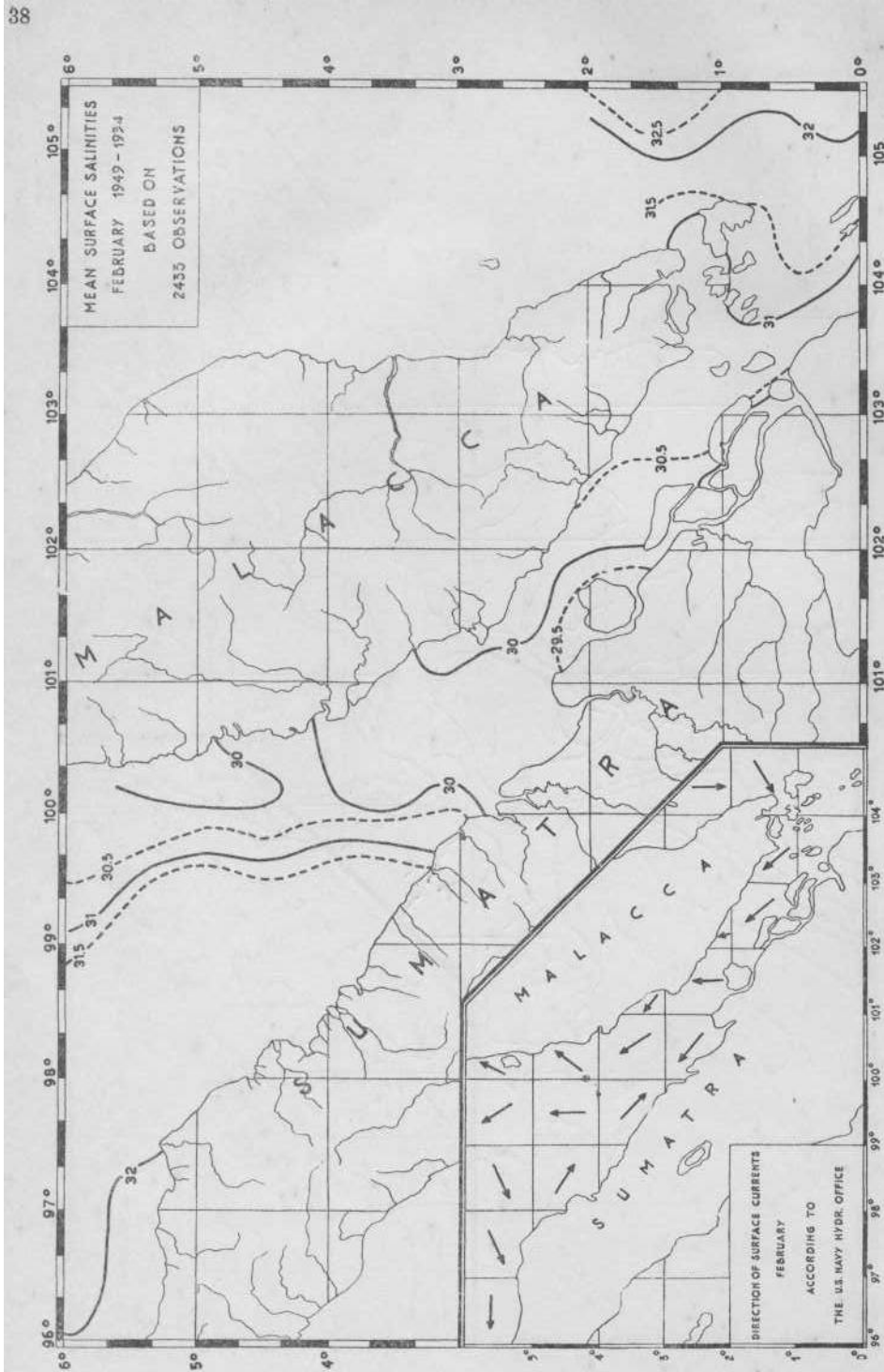
Sincerest thanks are due to Dr. K. WYRTKI oceanographer of the Lembaga Penyelidikan Laut at Djakarta and to Mr. E. H. DAHLGREN fishery adviser to the I.C.A. in Indonesia, for their many helpful criticisms and suggestions in preparing this paper.

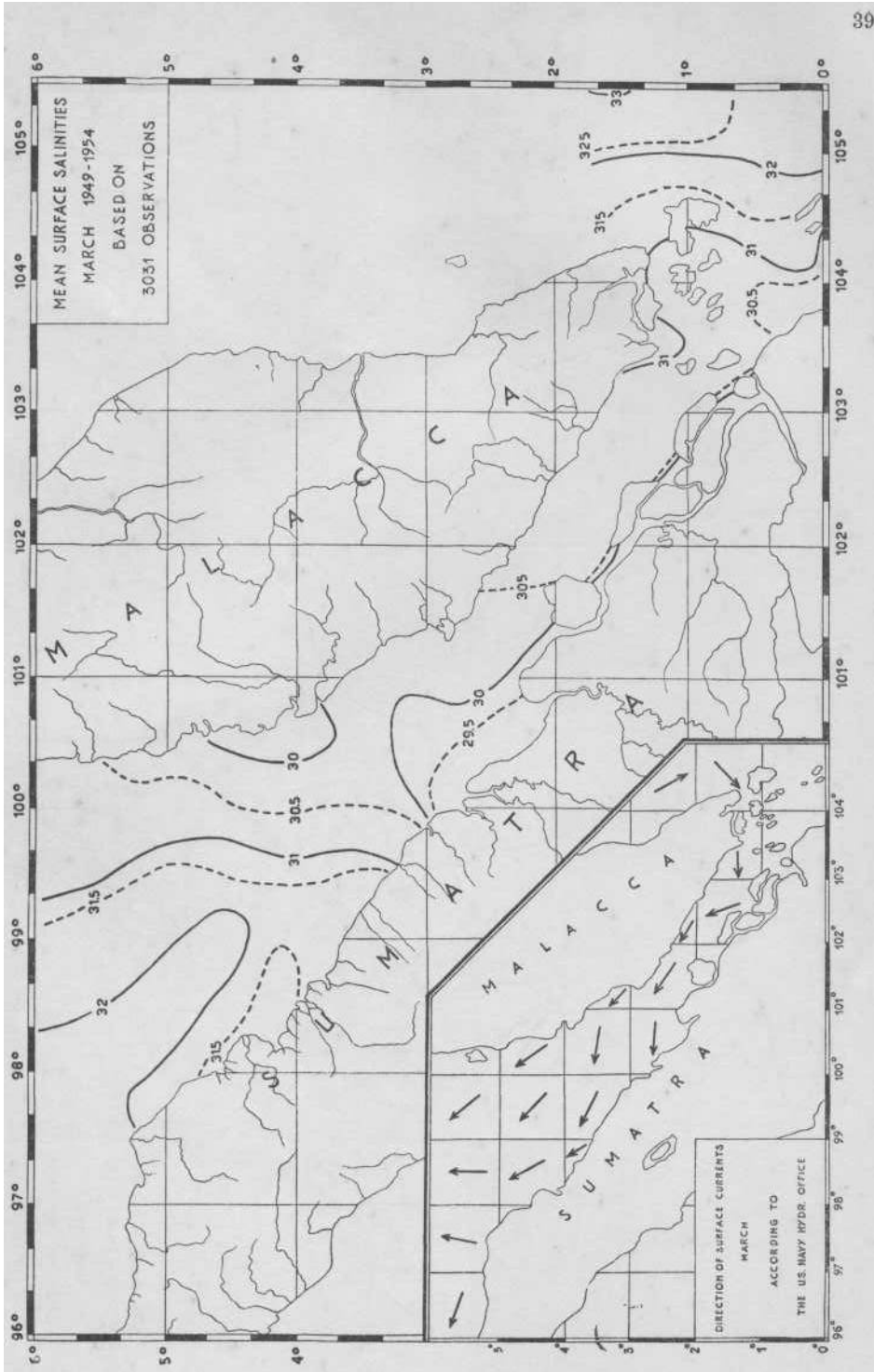
Finally to Mr. P. CH. VEEN former oceanographer of the Lembaga Penyelidikan Laut at Djakarta for his keen interest in collecting most of the data used in this paper.

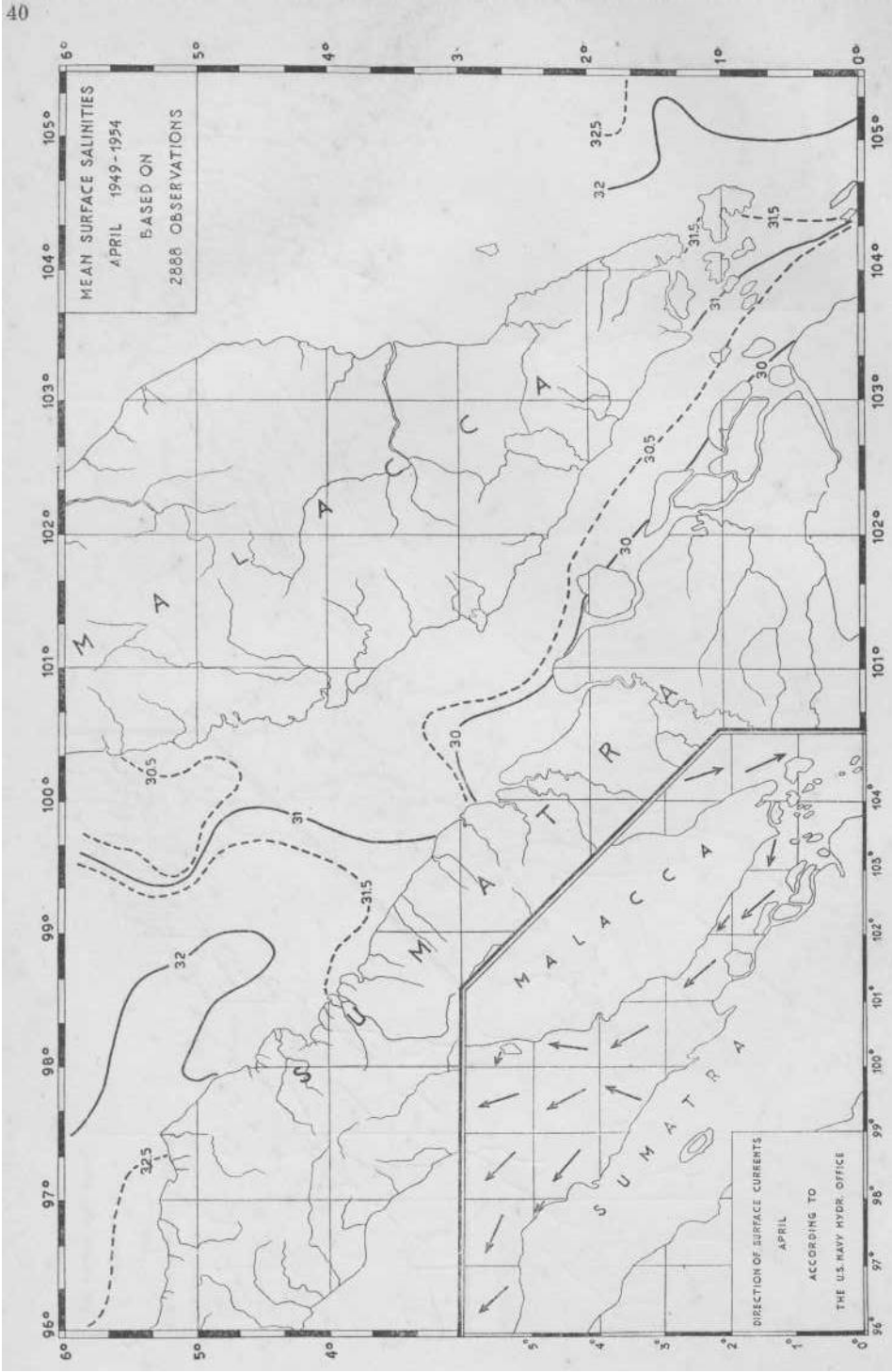
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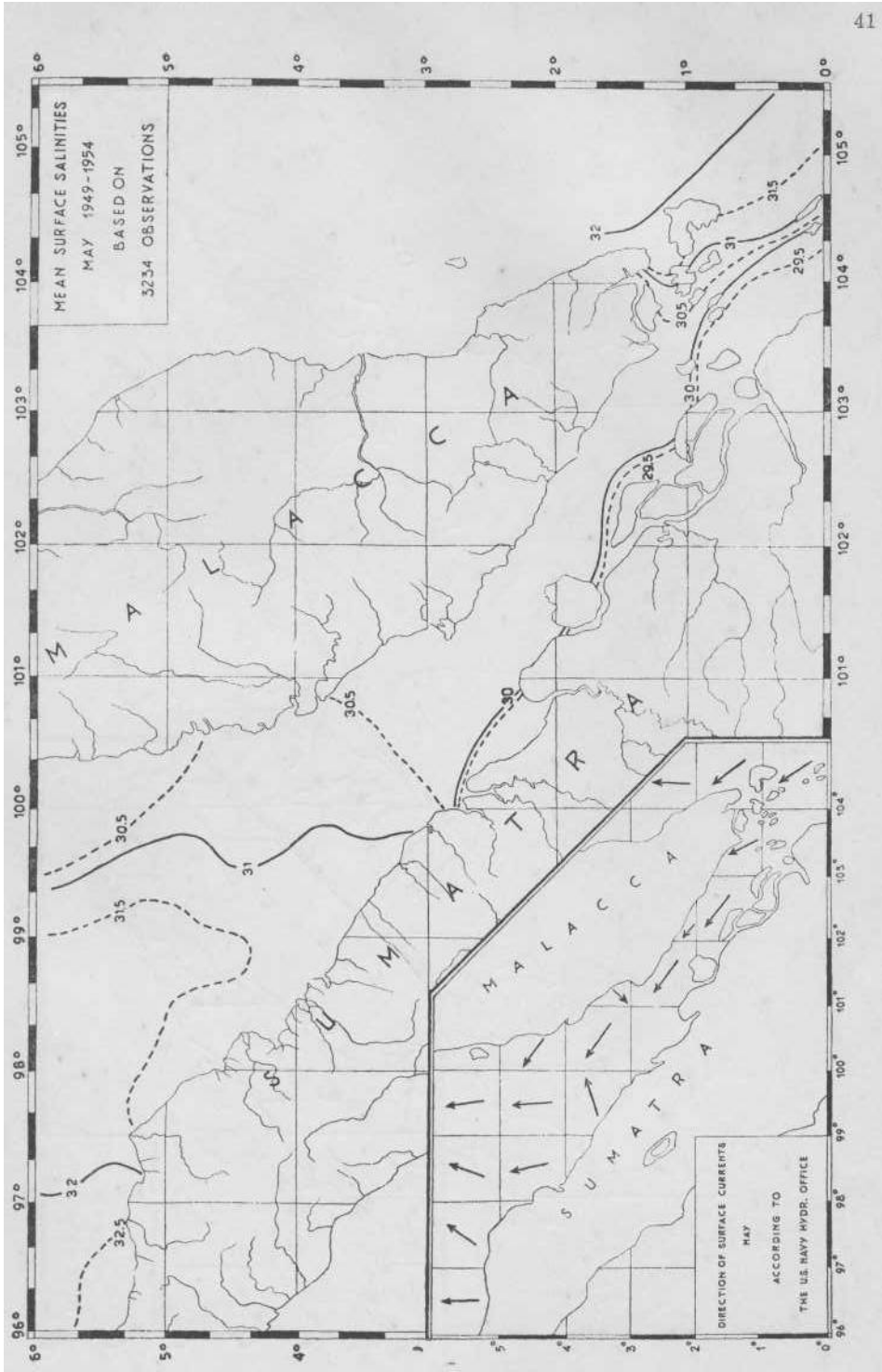
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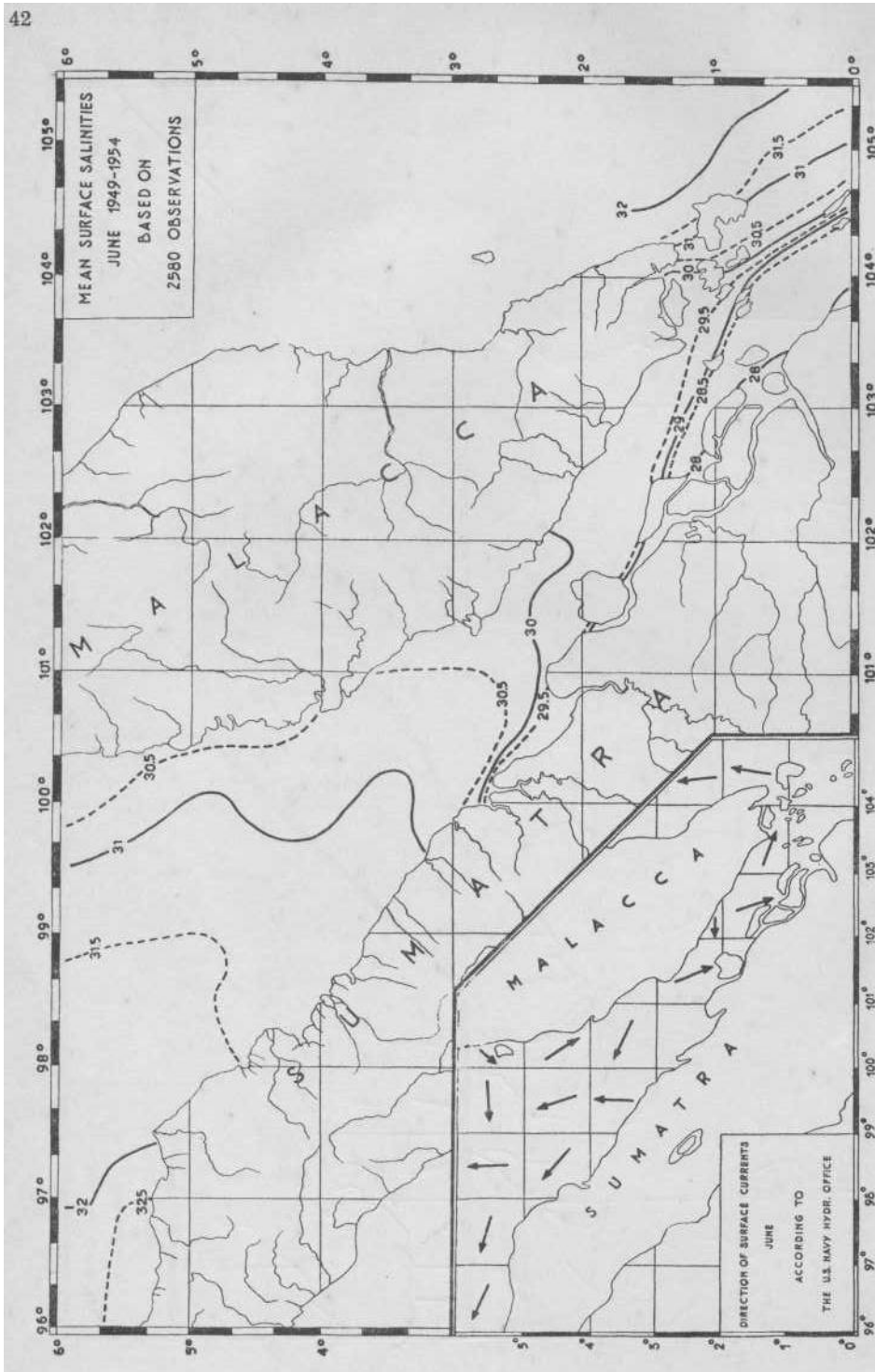


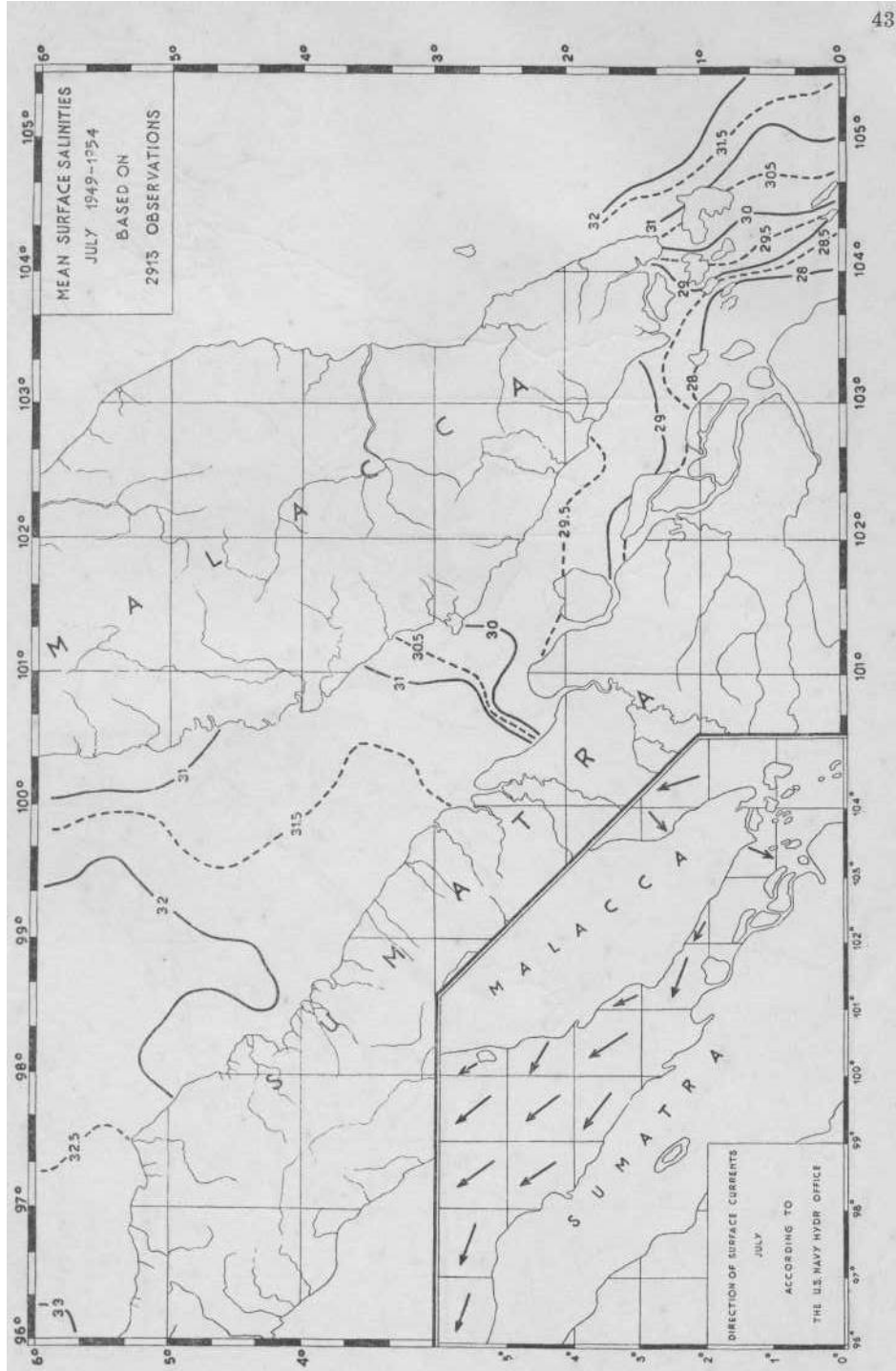


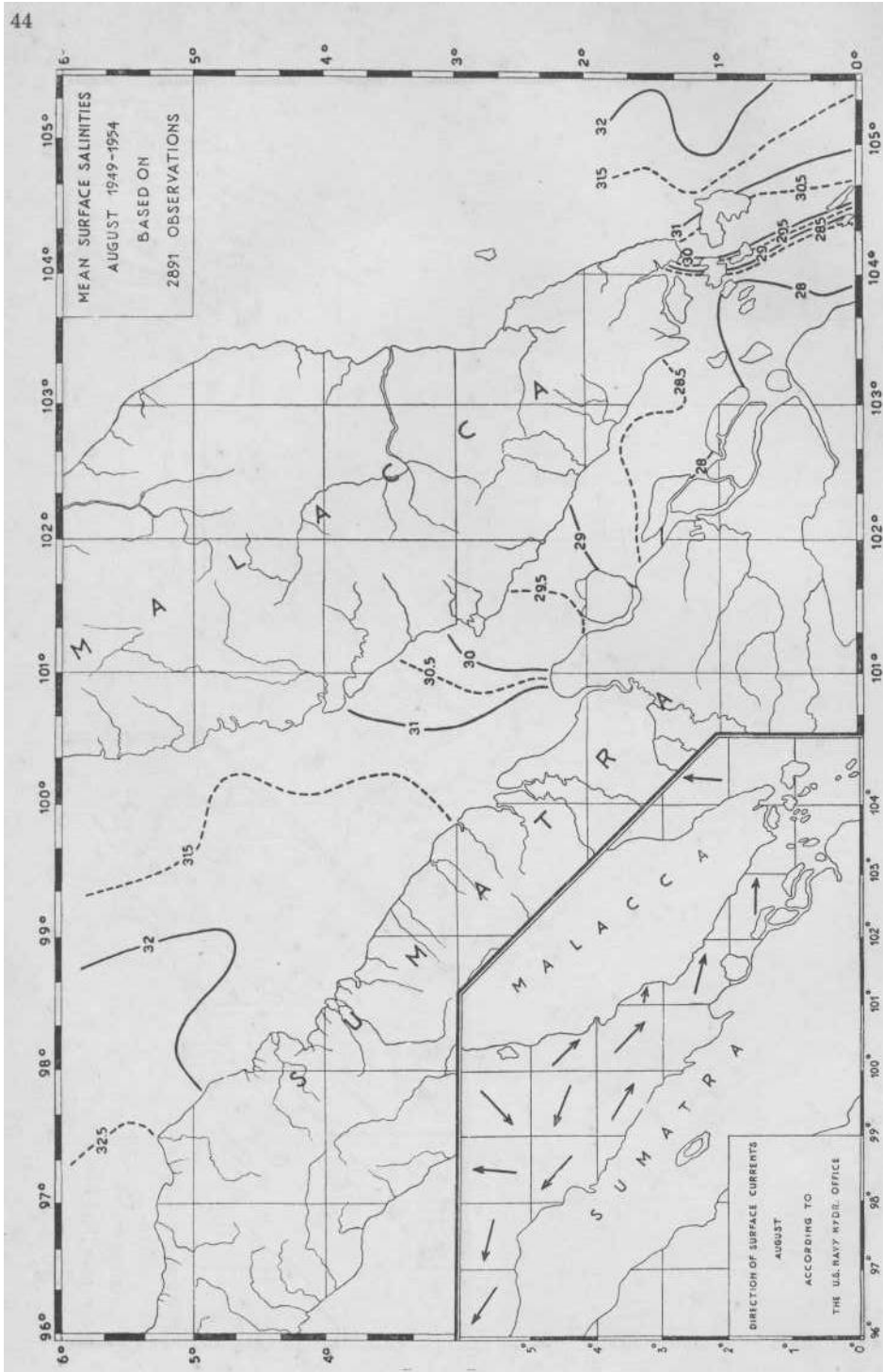


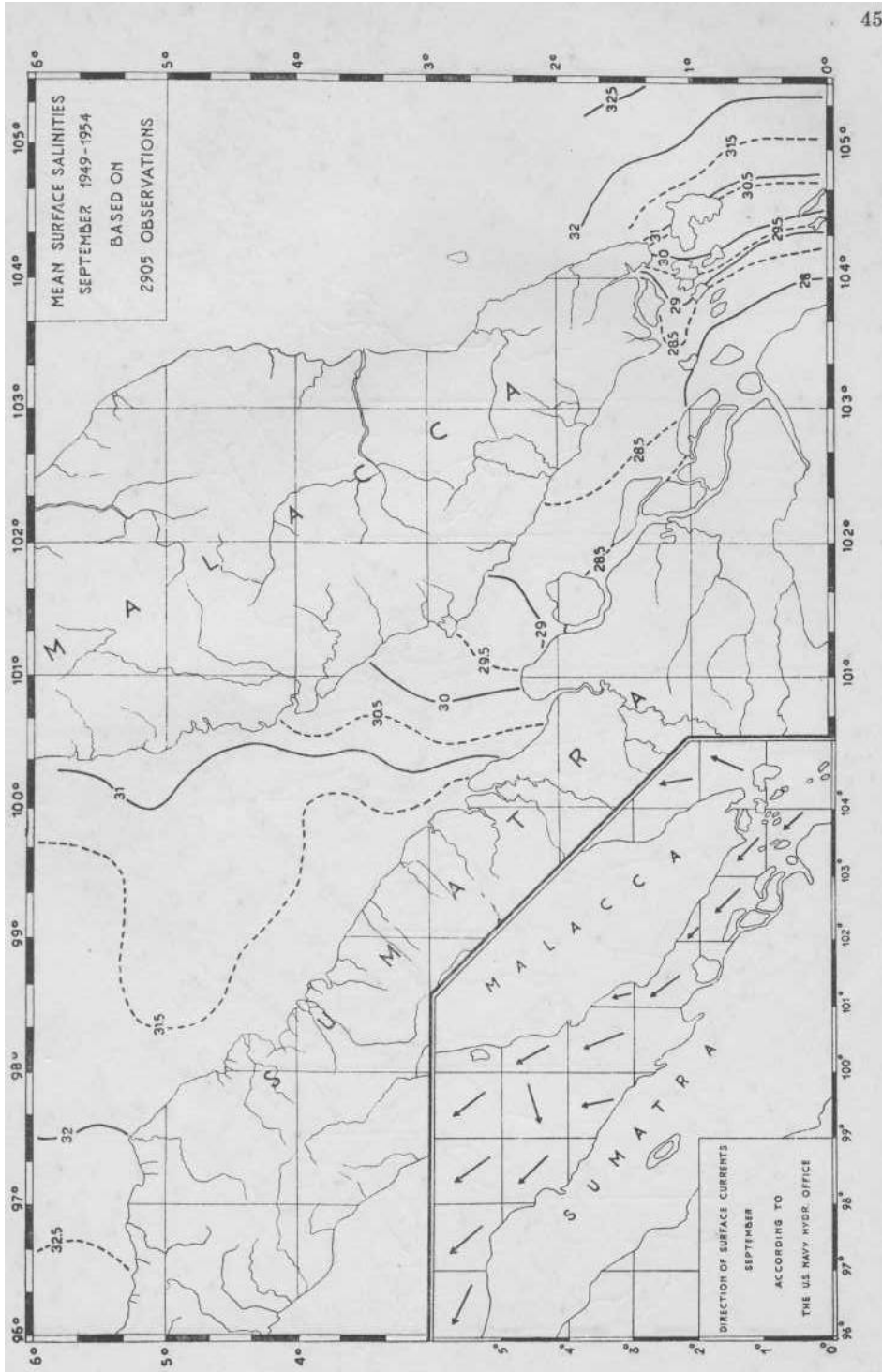


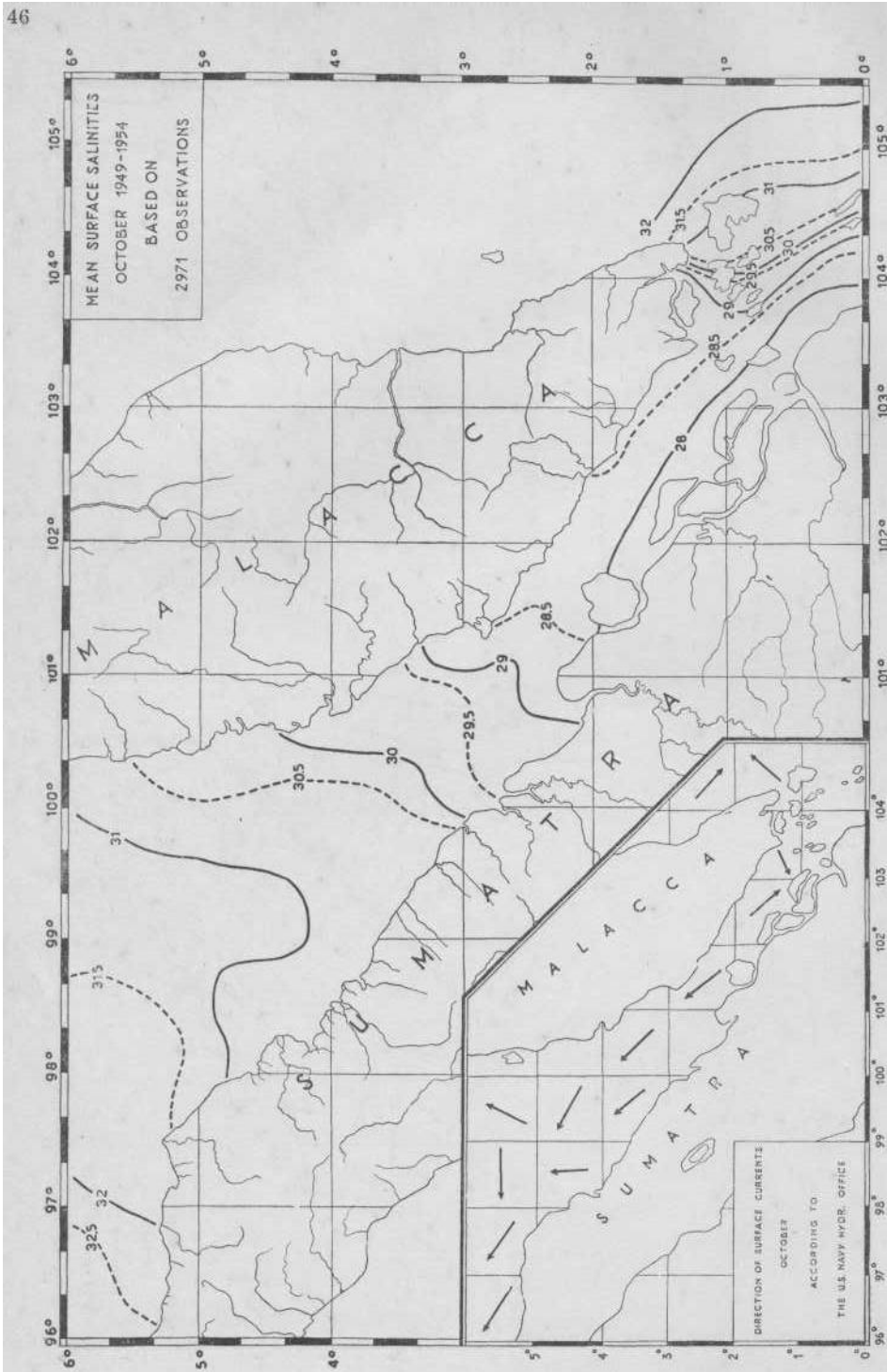


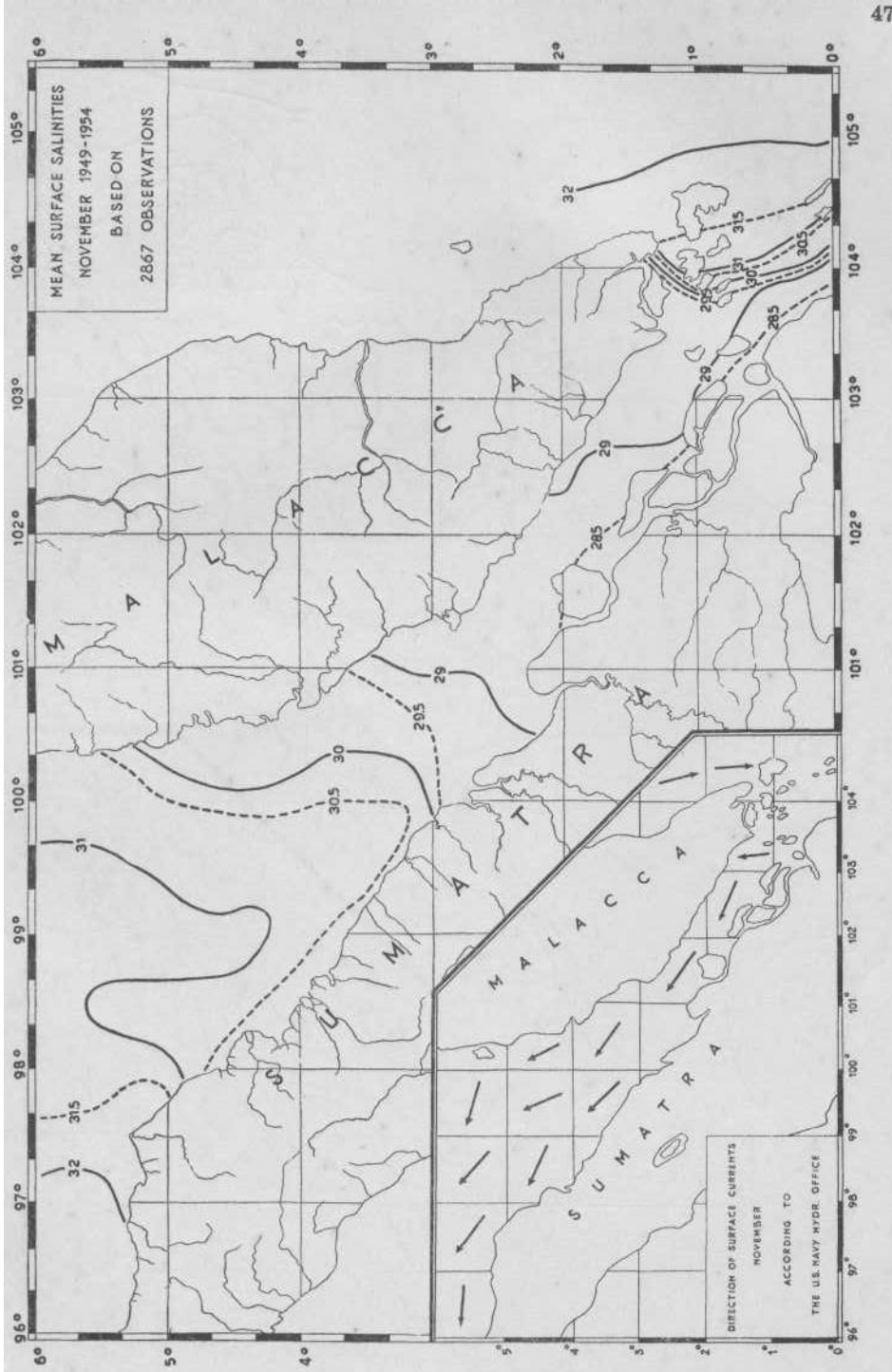


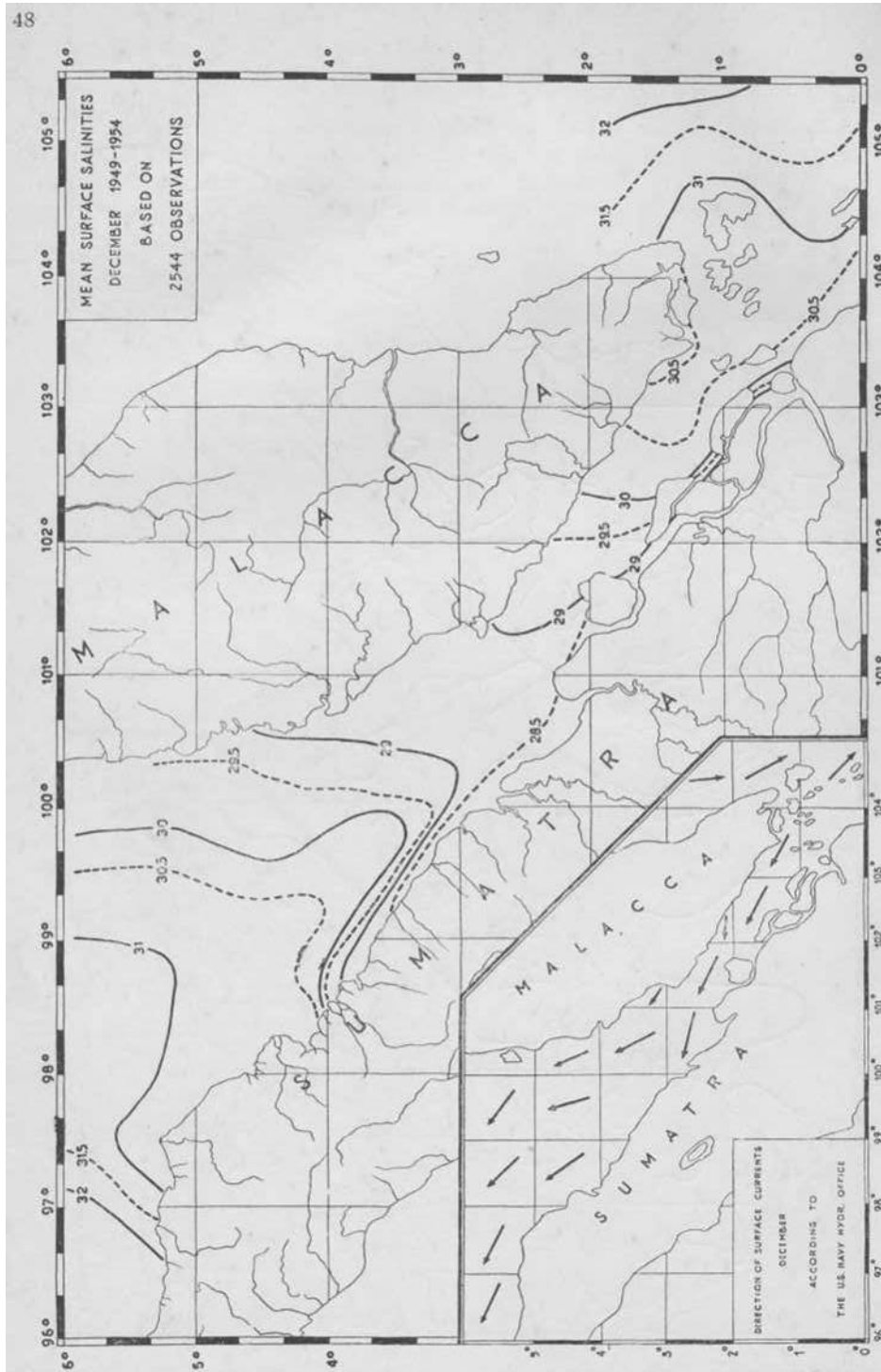












OCEANOGRAPHIC STATION LIST 1956

Oceanographic stations obtained by research vessel *Samudera* in 1956 in the Java Sea, the Flores Sea, the Celebes Sea and the waters around the island Halmahera.

Depth in meters, fat meters refer to thermometric depth. Temperatures in Centigrade, corrected, Salinities in ‰, Oxygen in ml/liter.

Station 1. 15-1-1956, 1200 ^h 3° 03' S. 107° 19' E. Depth: 53 m. Wind: N 3				Station 5. 18-1-1956 0830 ^h 4° 10' S. 111° 55' E. Depth: 35 m. Wind: W 3.			
m	t	S	O ₂	m	t	S	O ₂
0	27,0	31,89	—	0	27,4	31,51	—
10	27,40	32,36	4,56	5	27,56	31,41	—
20	27,37	32,34	—	10	27,71	31,44	4,75
30	27,38	32,34	—	15	27,40	31,37	—
40	27,37	32,34	—	20	27,41	31,40	—
50	27,38	32,34	4,50	25	27,43	31,44	—
Station 2. 16-1-1956 1200 ^h 1° 50' S. 108° 38' E. Depth: 42 m. Wind: N 3-4				Station 6. 18-1-1956 1800 ^h 4° 30' S. 113° 23' E. Depth: 48 m. Wind: W 1.			
m	t	S	O ₂	m	t	S	O ₂
0	27,7	32,79	—	0	27,7	31,20	—
10	27,35	32,77	4,52	5	27,90	31,15	—
20	27,30	32,77	—	10	27,70	31,15	4,59
30	27,30	32,75	—	15	27,43	31,16	—
40	27,32	32,68	4,69	20	27,40	31,19	—
Station 3. 17-1-1956 10.00 ^h 3° 34' S. 109° 10' E. Depth: 46 m. Wind: W 4.				Station 7. 19-1-1956 0600 ^h 4° 43' S. 115° 18' E. Depth: 28 m. Wind: 0			
m	t	S	O ₂	m	t	S	O ₂
0	27,2	32,52	—	0	27,7	30,97	—
10	27,30	32,86	4,61	5	27,79	30,86	—
20	27,33	32,86	—	10	27,75	31,09	4,73
30	27,34	32,86	4,53	15	27,70	31,22	—
40	27,31	32,91	4,66	20	27,68	31,29	—
Station 4. 17-1-1956 1900 ^h 3° 45' S. 110° 15' E. Depth: 34 m. Wind: W 3.				Station 8. 19-1-1956 0600 ^h 4° 43' S. 115° 18' E. Depth: 28 m. Wind: 0			
m	t	S	O ₂	m	t	S	O ₂
0	27,6	31,46	—	0	27,7	30,97	—
10	27,57	31,33	4,65	5	27,79	30,86	—
20	27,62	31,34	—	10	27,75	31,09	4,73
30	27,62	31,33	4,69	15	27,70	31,22	—
				20	27,68	31,29	—
				25	27,62	31,31	4,52

Station 8. 19-1-1956 1900h

4° 49' S. 117° 03' E.

Depth: 48 m. Wind: 0

m	t	S	O ₂
0	28,4	31,91	—
10	28,32	31,83	4,70
20	28,16	31,89	—
30	28,11	31,91	—
40	28,10	31,94	4,46
45	28,10	32,00	—

Station 9. 20-1-1956 0600-0700h

5° 01' S. 118° 01' E.

Depth: 1200 m. Wind: E 1.

m	t	S	O ₂
0	28,1	32,36	—
20	28,09	32,38	4,51
40	28,18	32,54	—
60	27,70	33,13	—
80	27,17	33,58	—
100	26,14	34,03	3,84
120	20,97	34,63	3,50
140	18,26	34,71	3,57
160	17,65	34,72	3,49
180	17,51	34,72	3,48
200	—	34,71	3,36
250	13,61	34,54	3,08
300	10,40	34,48	2,69
350	9,37	34,49	2,64
400	8,93	23,49	2,49
500	(8,00)	34,56	2,44

Station 10. 20-1-1956 1100-1200h

5° 03' S. 118° 34' E.

Depth: 800 m. Wind: E 1.

m	t	S	O ₂
0	28,8	32,30	—
20	28,17	32,36	4,55
40	28,12	32,61	—
60	27,90	32,95	—
80	27,10	33,77	—
100	24,10	34,54	3,81
120	21,97	34,72	3,74
140	19,67	34,77	3,70

160	18,96	34,76	3,49
180	16,02	34,73	3,47
200	15,90	—	3,49
250	11,44	34,49	2,89
300	10,30	34,42	2,74
350	8,95	34,48	2,48
400	8,39	34,49	2,35
500	7,19	34,52	2,46

Station 11. 20-1-1956 1530-1630h

5° 06' S. 118° 56' E.

Depth: 510 m. Wind: N 2

m	t	S	O ₂
0	28,4	32,56	—
20	28,24	32,47	4,67
40	28,24	32,41	—
60	27,90	32,63	—
80	23,81	34,54	—
100	21,97	34,63	3,76
120	21,02	34,74	—
140	20,66	34,78	3,69
160	20,28	34,79	—
180	16,90	34,65	—
200	14,80	34,67	3,16
250	12,53	34,56	—
300	11,04	34,51	2,70
350	9,30	34,49	2,53
400	7,80	34,49	2,46
500	6,75	34,52	2,41

Station 12. 23-1-1956 2200-2300h

5° 44' S. 118° 38' E.

Depth: 870 m. Wind: NW 2

m	t	S	O ₂
0	28,2	32,18	—
20	28,18	32,18	4,69
40	28,22	32,36	—
60	28,09	32,74	—
80	25,66	34,20	—
100	24,32	34,47	4,04
120	21,59	34,76	3,82
140	19,70	34,76	3,79
160	19,13	34,76	3,75
250	13,22	34,56	3,15

Station 13. 24-1-1956 04-06^h

6° 15' S. 118° 35' E.

Depth: 360 m. Wind: W 3-4

m	t	S	O ₂
0	28,1	32,03	—
20	28,10	32,18	4,77
40	27,40	33,08	—
60	25,76	33,89	—
80	24,23	34,27	—
100	22,39	34,65	3,85
114	21,06	34,65	3,77
133	19,57	34,70	3,72
152	18,95	34,70	3,72
170	17,70	34,69	3,56
190	16,31	34,65	3,47
230	14,35	34,54	3,35
253	13,61	34,54	3,15
276	12,42	34,47	3,01
299	11,34	34,47	2,94
322	9,60	34,41	2,59

Station 14. 24-1-1956 10^h-12^h

6° 32' S. 118° 17' E.

Depth: 285 m. Wind: W 2-3

m	t	S	O ₂
0	28,3	32,01	—
20	28,09	31,92	4,56
40	28,10	32,10	—
60	27,20	33,08	—
80	25,48	33,80	—
100	21,89	34,65	3,69
120	20,21	34,70	3,78
140	18,37	34,70	3,64
160	17,74	34,70	—
180	16,64	34,69	3,60
200	15,40	34,61	3,49
225	14,30	34,54	3,49
250	13,01	34,40	3,14
280	11,97	—	2,99

Station 15. 24-1-1956 18-1930^h

6° 40' S. 117° 26' E.

Depth: 380 m. Wind: W 2-3

m	t	S	O ₂
0	28,0	32,25	—
20	28,07	32,19	4,83
40	27,88	32,52	—
60	27,82	32,50	—

80	26,00	33,16	—
100	25,48	33,93	4,22
120	21,37	34,58	3,80
140	20,31	34,67	3,71
160	18,71	34,72	3,67
180	16,90	34,65	3,55
200	15,27	34,65	3,53
230	14,18	34,61	3,41
280	11,80	34,54	3,02
325	9,88	34,51	2,61
350	9,39	34,49	2,48

Station 16. 25-1-1956 0100-0240^h

6° 45' S. 116° 46' E.

Depth: 600 m. Wind: SW 2-3

m	t	S	O ₂
0	28,2	32,22	—
20	28,14	32,21	4,30
40	28,20	32,21	—
60	28,00	32,55	—
80	27,91	32,70	—
100	24,52	34,23	3,91
120	20,08	34,66	3,75
140	16,55	34,71	3,49
160	15,80	34,67	3,39
180	15,10	34,61	3,44
200	14,61	34,59	3,32
250	13,76	34,60	3,31

Station 17. 26-1-1956 17.00^h

6° 33' S. 112° 05' E.

Depth: 46 m. Wind: W 3

m	t	S	O ₂
0	27,75	32,06	—
10	27,84	32,01	—
20	27,88	31,95	—
30	27,88	31,96	—
40	27,90	31,90	—

Station 18. 27-1-1956 12.00^h

6° 09' S. 109° 20' E.

Depth: 50 m. Wind: W 2

m	t	S	O ₂
0	27,4	31,86	—
10	27,42	31,86	—
20	27,42	31,88	—
30	27,43	31,92	—
40	27,41	31,99	—
50	27,41	32,02	—

Station 19. 12-6-1956 0730-0900h
7° 52' S. 116° 30' E.
Depth: 1500 m. Wind: SE 2

m	t	S	O ₂
0	28,7	32,72	—
20	28,66	32,68	4,54
50	27,84	33,69	4,34
65	26,39	34,20	3,92
80	25,93	34,25	4,04
95	25,24	34,36	4,05
115	24,60	34,43	3,87
132	23,45	34,61	3,88
150	21,38	—	3,56
167	19,67	34,61	3,49
210	14,57	34,61	3,27
250	12,30	34,54	3,00
335	10,36	34,49	2,68
450	10,05	34,49	2,58
550	—	34,56	2,32
650	6,48	34,58	2,30
750	5,71	34,58	2,06
850	5,20	34,56	2,14
950	4,77	34,58	2,15

Station 20. 12-6-1956 2000-2130h
6° 58' S. 117° 43' E.
Depth: 510 m. Wind: E 2

m	t	S	O ₂
0	28,6	33,40	—
18	28,60	33,21	4,69
36	28,37	33,37	4,70
54	28,09	33,60	4,64
72	26,61	34,05	4,39
90	25,62	34,40	3,95
110	23,71	34,49	3,89
140	21,63	34,70	—
160	19,59	34,67	3,61
180	18,49	34,69	—
200	16,91	34,63	3,45
250	14,88	34,60	3,39
280	12,59	34,49	3,11
300	11,82	34,49	2,99
320	10,30	34,42	2,69
420	8,90	34,43	2,45

Station 21. 13-6-1956 1200-1400h
5° 41' S. 118° 56' E.
Depth: 1010 m. Wind: E 3-4

m	t	S	O ₂
0	28,1	33,77	—
20	27,60	34,00	4,65
40	25,87	34,36	4,28
60	24,79	34,54	4,07
80	24,63	34,56	3,95
100	24,64	—	—
120	22,22	34,72	3,81
140	22,29	34,69	3,81
160	20,90	34,74	3,61
180	20,11	34,69	3,68
200	19,19	34,69	3,59
250	16,42	34,63	3,37
300	11,84	34,52	2,95
360	10,07	34,47	2,89
455	8,70	34,49	2,45
550	7,47	34,51	2,46
645	6,38	34,54	2,41
740	5,98	—	—
830	5,32	34,54	2,30

Station 22. 19-6-1956 1700-1900h
1° 10' N. 122° 40' E.
Depth: > 2000 m. Wind: E 1

m	t	S	O ₂
0	29,8	33,98	—
20	28,31	34,13	4,54
40	27,37	34,38	4,62
60	26,82	34,38	4,55
80	25,77	34,42	4,19
100	22,27	34,72	3,90
120	20,40	34,76	3,74
140	20,37	34,79	3,80
160	19,02	34,76	3,71
180	18,26	34,74	3,77
200	17,15	34,67	3,68
250	13,06	34,51	3,33
300	12,29	34,43	3,27
400	9,34	34,49	2,70
500	7,64	34,51	2,64
600	6,84	34,54	2,56
700	6,21	34,52	2,52

800	5,74	—	—
900	5,15	34,54	2,36
1080	4,53	34,56	2,24
1280	3,96	34,60	2,33

Station 23. 22-6-1956 1600-1800h
1° 06' N. 126° 32' E.
Depth: 1800 m. Wind: NE 2

m	t	S	O ₂
0	29,5	33,48	—
20	29,37	33,89	5,20
40	28,73	33,98	4,62
60	28,17	34,02	4,77
80	26,92	34,27	4,42
100	25,70	34,56	4,34
120	24,16	34,61	4,31
140	22,03	34,73	3,99
160	20,96	34,76	3,93
180	16,63	34,67	3,66
200	16,04	34,65	—
250	12,61	34,56	3,14
300	11,74	34,58	2,94
400	9,98	34,54	2,91
500	7,69	34,58	2,46
570	6,87	34,54	2,50
670	6,15	34,56	2,58
765	5,61	34,56	2,57
860	5,16	34,54	2,55
960	4,55	34,56	2,43
1160	3,86	34,61	2,44

Station 24. 24-6-1956 0800-0930h
0° 14' S. 127° 36' E.
Depth: 610 m. Wind: N 1.

m	t	S	O ₂
0	29,1	32,75	—
20	28,75	32,97	4,84
40	27,92	33,01	4,70
60	26,46	33,24	(5,06)
80	25,36	33,37	3,87
100	23,59	34,38	3,57
120	21,93	34,43	3,47
140	20,86	34,54	3,46
160	19,10	34,56	3,30
180	17,81	34,54	3,27
200	16,94	34,58	3,17

250	12,82	34,60	2,87
370	10,04	34,60	2,63
420	9,76	34,61	2,55
470	9,57	34,61	2,62
520	9,43	34,56	2,57
570	9,27	34,54	2,54
600	9,23	34,56	2,62

Station 25. 24-6-1956 1200-1330h
0° 33' S. 127° 48' E.
Depth: > 2000 m. Wind: N 1

m	t	S	O ₂
0	29,4	33,93	—
20	28,61	33,91	5,10
40	28,26	33,95	4,98
60	27,23	34,00	4,75
80	26,19	34,14	4,25
100	24,08	34,25	4,09
120	22,08	34,43	3,69
140	21,29	34,45	3,52
160	19,54	34,52	3,39
180	17,28	34,61	3,19
200	16,16	34,67	3,20
250	14,56	34,67	3,17
300	12,54	34,67	3,01
400	9,05	34,61	2,76
500	8,38	34,60	2,83
600	8,19	34,60	2,64
670	8,12	34,61	2,84
765	8,08	34,63	2,75
860	8,01	34,61	2,66
960	8,01	34,65	2,63
1060	8,00	34,65	2,55
1160	7,97	34,65	2,59

Station 26. 24-6-1956 1600-1800h
0° 57' S. 127° 52' E.
Depth: 1500 m. Wind: W 2.

m	t	S	O ₂
0	28,0	32,75	—
20	29,07	34,18	4,79
60	28,72	34,58	4,73
80	28,11	34,83	4,48
100	27,36	34,87	4,47
120	24,53	34,92	3,81
140	22,32	34,96	3,45
160	20,93	34,90	3,44

54

180	19,43	34,94	3,42
200	18,54	34,90	3,28
250	15,10	34,69	3,21
300	12,68	34,65	2,97
400	9,93	34,61	2,86
500	8,11	34,56	2,78
600	7,32	34,56	2,81
800	5,82	34,56	2,64
980	5,00	34,60	(2,94)
1070	4,34	34,60	2,77
1170	3,78	34,60	2,94

Station 27. 25-6-1956 0530-0700h
 2° 00' S. 127° 00' E.
 Depth: > 2000 m. Wind: N 1.

m	t	S	O ₂
0	28,5	34,16	—
20	28,88	34,25	4,62
55	27,66	34,43	4,41
75	27,08	34,47	4,30
95	25,63	34,65	4,01
110	23,77	34,78	3,68
130	23,25	34,83	3,66
160	22,90	34,87	3,58
180	21,49	34,78	3,41
200	19,15	34,76	3,28
250	15,05	34,61	2,89
300	11,63	34,63	2,80
400	9,23	34,60	2,68
500	7,76	34,63	2,67
600	7,10	34,60	2,67
800	5,72	34,60	2,71
1000	4,53	34,60	2,67
1100	4,29	34,60	2,54
1200	4,04	34,61	2,71

Station 28. 25-6-1956 1800-1930h
 3° 32' S. 127° 38' E.
 Depth: > 3000 m. Wind: 0

m	t	S	O ₂
0	29,0	34,40	—
20	28,60	34,36	4,92
60	27,66	34,61	4,62
80	26,98	34,69	4,53
100	24,93	34,65	4,29
120	24,12	34,78	4,26
140	21,68	34,83	(4,25)

160	19,66	34,69	3,46
180	18,19	34,72	3,36
200	16,63	34,69	3,15
250	12,49	34,65	2,97
300	10,33	34,61	2,74
400	8,72	34,65	2,68
500	8,04	34,61	2,71
600	7,12	34,61	2,57
800	5,85	34,61	2,48
1000	4,83	34,61	2,31
1100	4,63	34,61	2,51
1200	4,43	34,61	2,81

Station 29. 28-6-1956 1530h
 3° 39' S. 128° 12' E.
 Depth: 38 m. Wind: 0

m	t	S	O ₂
10	28,50	34,13	4,54
15	28,28	34,22	4,25
20	27,67	34,29	3,19
25	27,41	34,29	2,66
30	27,36	34,29	2,35
35	27,11	34,29	2,59

Station 30. 30-6-1956 1600-1730h
 2° 55' S. 127° 26' E.
 Depth: > 2000 m. Wind: S 2

m	t	S	O ₂
0	29,2	34,70	—
20	28,99	34,60	4,57
60	28,34	34,92	4,14
80	28,32	34,96	4,47
100	27,62	34,99	4,06
120	26,87	35,03	3,81
140	25,90	35,08	3,69
160	22,95	35,08	3,31
180	22,23	34,99	3,36
200	20,44	34,99	3,11
250	16,77	34,74	2,84
300	13,00	34,70	2,75
380	10,44	34,70	2,71
470	8,57	34,70	2,34
565	7,21	—	—
760	6,58	34,58	2,46
955	4,87	34,63	2,49
1050	4,59	34,65	2,45
1140	4,34	34,69	2,44

Station 31. 1-7-1956 0230-0400h

1° 45' S. 128° 12' E.

Depth: 1600 m. Wind: SW 3

m	t	S	O ₂
0	28,3	34,27	—
20	28,92	34,14	4,42
60	27,70	34,72	4,04
80	26,72	34,81	3,79
100	25,71	34,96	3,58
120	24,98	34,96	3,71
140	22,60	34,97	3,48
160	17,56	34,76	3,02
180	16,95	—	—
200	16,04	34,74	2,85
250	14,97	—	—
300	13,41	34,72	2,85
400	9,85	34,65	2,58
540	7,97	34,61	2,41
640	6,80	34,61	—
840	5,40	34,61	2,45
1050	4,29	34,60	—
1160	4,09	34,58	2,40
1260	3,83	34,63	2,32

Station 32. 1-7-1956 1500-1700h

0° 12' S. 128° 49' E.

Depth: > 2000 m. Wind: W 3

m	t	S	O ₂
0	28,9	34,70	—
20	28,95	34,74	5,34
60	28,89	34,79	5,04
80	28,69	34,85	5,17
100	27,96	34,94	4,62
120	26,38	34,99	3,87
140	25,43	35,10	3,51
160	20,92	35,10	3,45
180	18,50	34,99	3,15
200	16,97	34,87	3,02
250	14,48	34,83	(3,32)
300	12,98	34,76	3,20
400	9,73	34,65	—
480	8,35	34,65	3,48
570	8,34	34,67	3,21
740	8,06	34,65	3,31
910	7,92	34,65	3,22
1000	7,90	34,67	3,17
1100	7,90	34,65	3,08

Station 33. 2-7-1956 0930-1100h

0° 51' N. 128° 46' E.

Depth: 1200 m. Wind: SW 1

m	t	S	O ₂
0	29,0	34,92	—
20	29,11	34,87	4,62
60	28,10	35,21	4,46
80	27,85	35,23	4,02
100	26,94	35,35	3,85
120	26,00	35,44	3,87
140	24,20	35,48	3,37
160	23,27	35,44	3,20
180	21,57	35,37	3,21
200	19,91	35,23	3,12
250	14,41	34,69	3,15
300	12,00	34,65	3,31
400	9,00	34,63	2,94
500	8,09	34,65	2,83
600	7,02	34,56	2,75
800	5,77	34,56	2,72
1000	4,63	34,56	2,60
1100	4,21	34,60	2,56

Station 34. 2-7-1956 1630-1800h

1° 43' N. 128° 41' E.

Depth: > 1300 m. Wind: W 2

m	t	S	O ₂
0	28,3	34,85	—
20	29,17	34,78	4,75
60	28,33	35,23	4,44
80	27,96	35,35	4,02
100	27,60	35,35	3,77
130	26,38	35,46	3,59
160	22,06	35,35	3,24
180	20,63	35,26	3,19
200	19,29	35,08	3,26
250	13,77	34,58	3,14
300	11,97	34,56	3,05
400	9,23	34,61	2,65
470	8,36	34,58	2,55
570	7,41	34,56	2,59
770	6,05	34,58	2,68
970	4,65	34,58	2,48
1070	4,18	34,61	2,46
1170	3,76	34,60	2,36