The Snellius Expedition.

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Since 27th July 1929 a Dutch deep-sea expedition has been engaged in the investigation of the inland seas between Asia and Australia, especially the deep basins in the eastern part of the East Indian Archipelago. This expedition was initiated by the Society for Scientific Research in the Dutch Colonies and the Royal Geographical Society at Amsterdam, with substantial aid from the Government both in Holland and in the Colony. These Governments lent the vessel, H. M.S. "Willebrord Snellius", met the cost of crew and maintenance during the cruise, and contributed towards the funds, one half being supplied privately. The Leader of the expedition is Commander P. M. VAN RIEL, Chief of the Oceanographical Department, Royal Dutch Meteorological Institute. The scientific staff further consists of Dr. H. J. HARDON and H. C. HAMAKER (oceanography), Dr. A. B. BOELMAN (chemistry), Dr. PH. H. KUENEN (geology), Dr. H. BOSCHMA (biology), while Commander F. PINKE and his officers take charge of echo-soundings, determine positions and some of the crew aid in laboratory work. It was a happy coincidence that the expedition was simultaneous with the gravity expedition on submarines of Prof. VENING MEINESZ, which supplied much additional information on the configuration of the sea bottom and indicated localities of special interest, receiving in turn useful information from the Snellius expedition.

The reports received, partly published in the "Tijdschrift Aardrijkskundig Genootschap", cover the first year of the expedition. On August 12th, 1930, the Snellius entered upon the final quarter. Figs. 1, 2 and 3 give an idea of the track and the number of oceanographic stations, which already surpass 300, the total number of salinity determinations

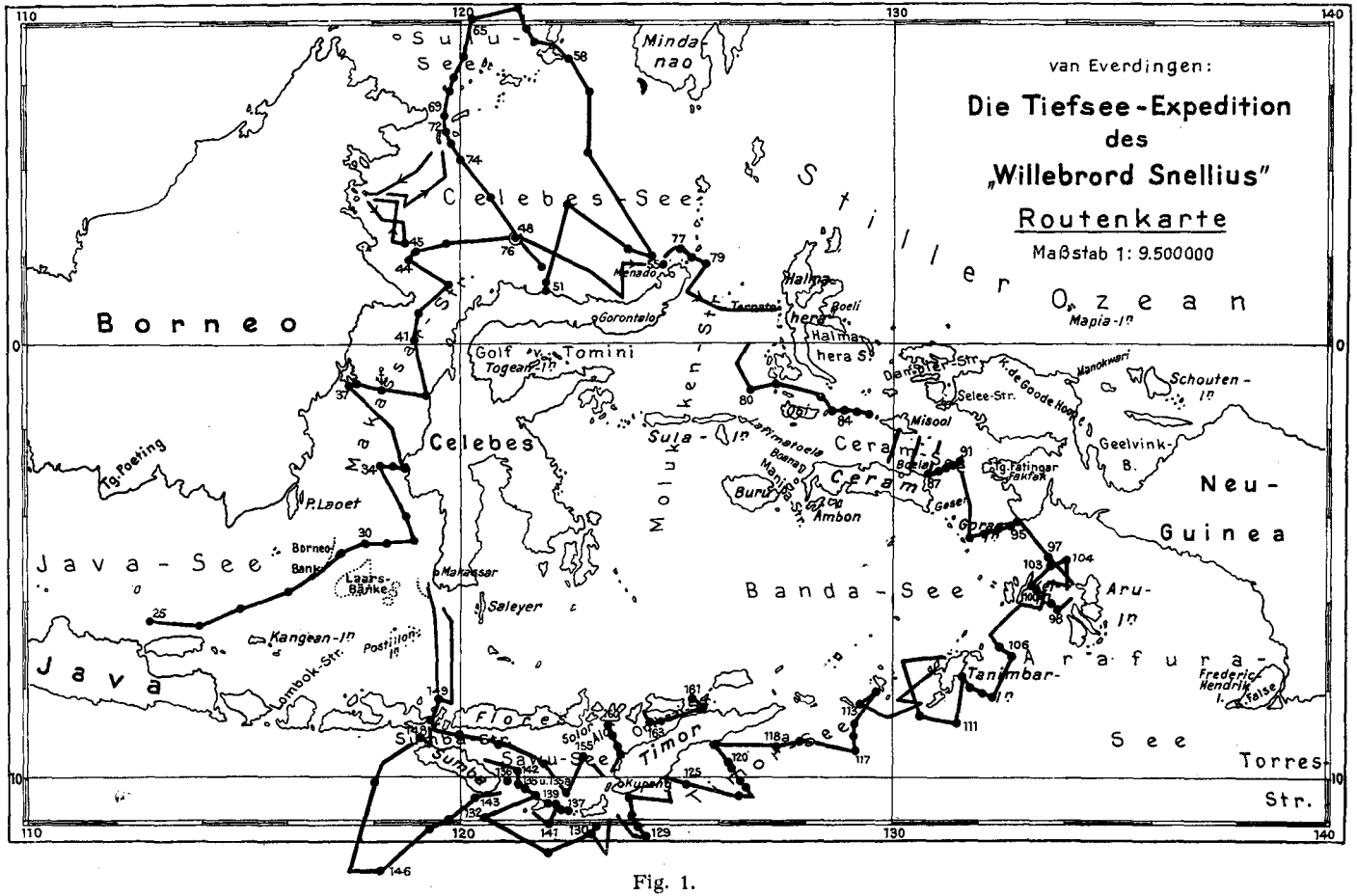

Fig. 1.

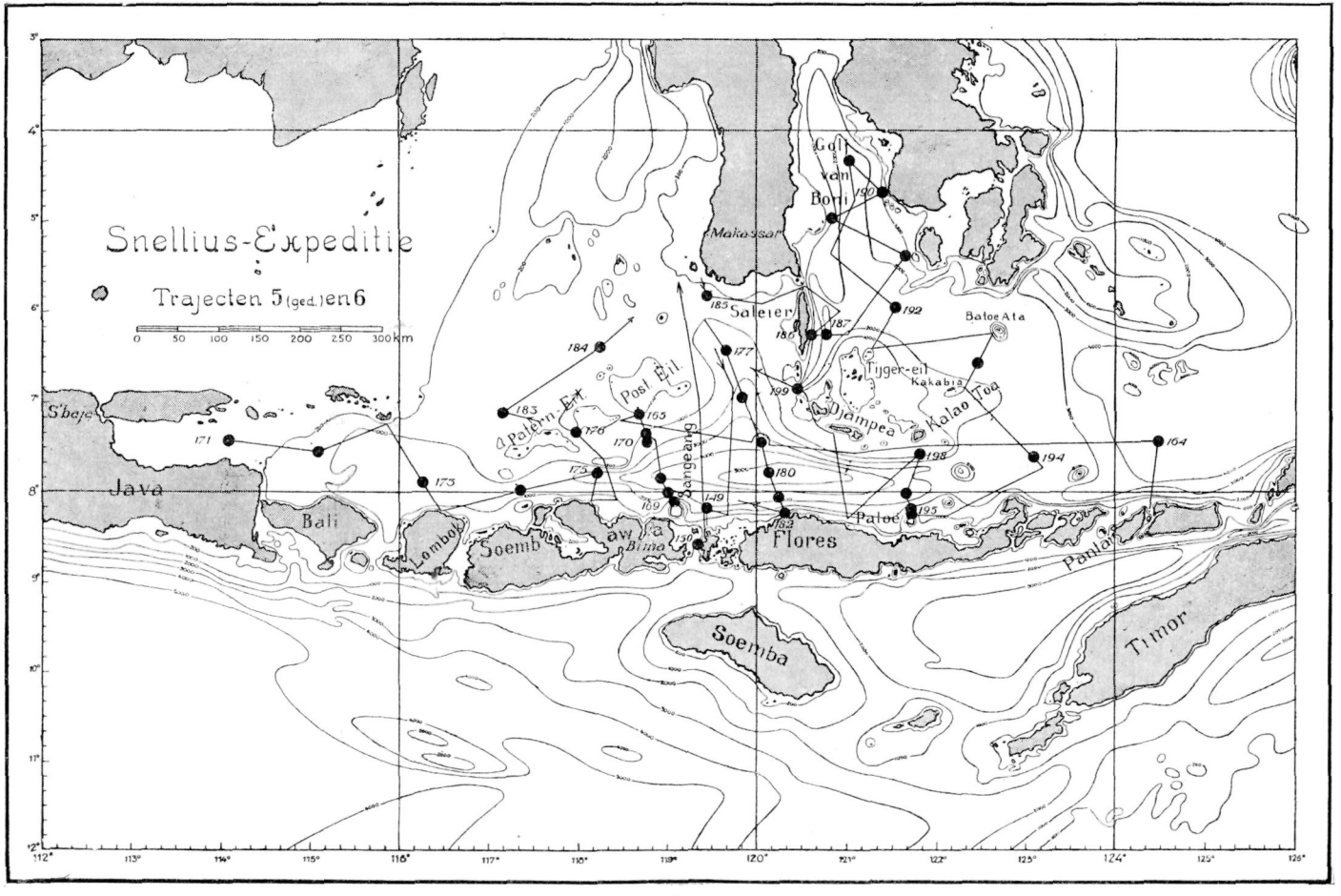

Fig. 2.

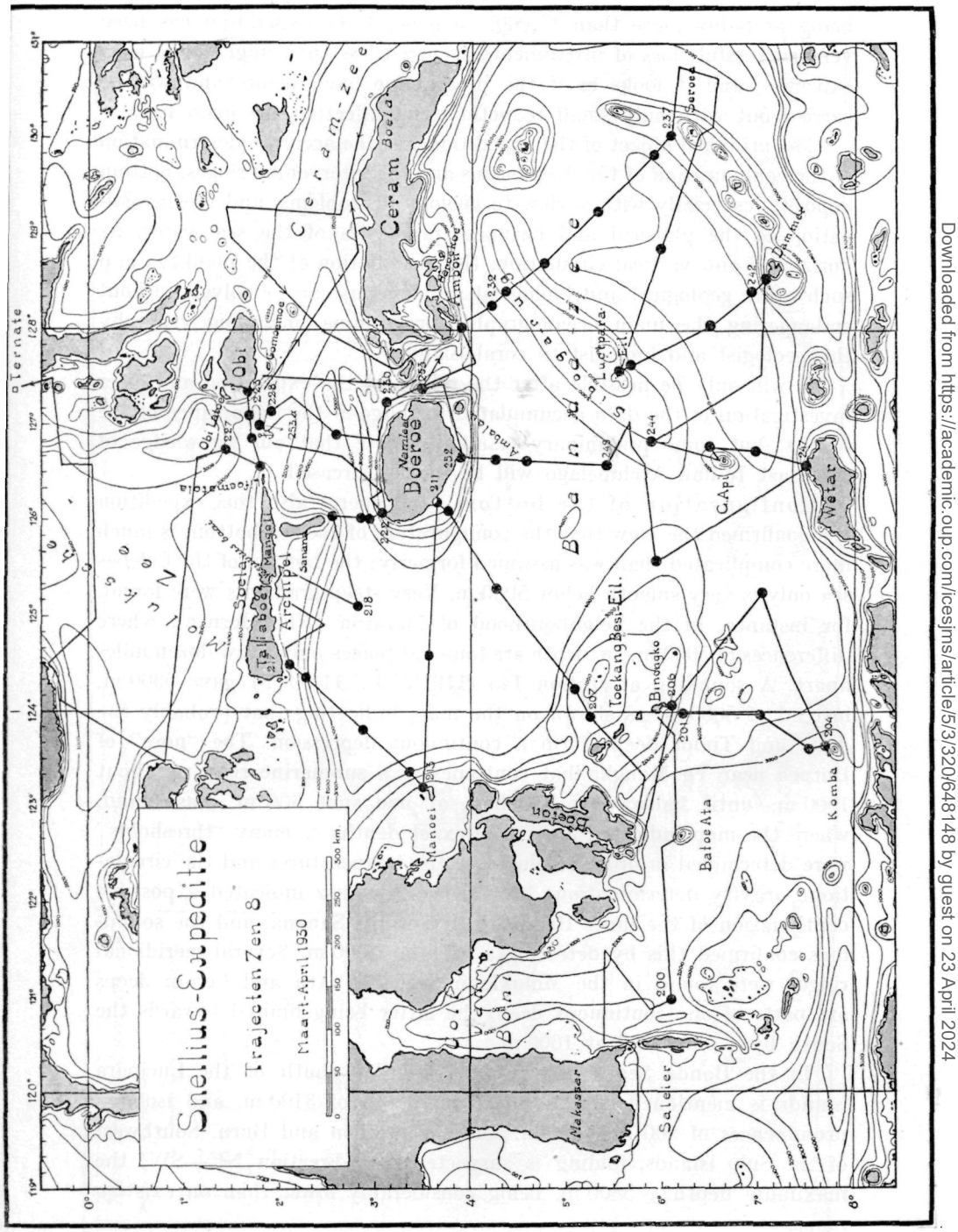

Fig. 3.

being probably more than 15,000. In general the expedition has been very successful; loss of instruments occurred less than might have been expected, and it looks as if the programme fixed beforehand will be carried out with only small reductions not affecting the main lines.

The principal object of the expedition was the accurate determination of the configuration of the deep basins and the intervening ridges, bottom deposits, especially with a view to geological problems, and the investigation of the physical and chemical properties of the sea water, its horizontal and vertical circulation, the distribution of the plankton and such other geological and biological problems as can be solved without endangering the main oceanographic programme, including visits by the geologist and biologist to coral islands.

It will only be possible after the return of the expedition and after investigation of the data accumulated to judge of the importance of the results, but some preliminary results indicate that our knowledge of the East Indian Archipelago will be much increased.

Configuration of the bottom. In general also this expedition has confirmed the view that the configuration of the sea-bottom is much more complicated than was assumed formerly; the bottom of the Celebes sea only is very smooth below 5000 m. Very steep gradients were found, for instance, in the neighbourhood of Maratua (NE. Borneo), where differences of 5000 m. in depth are found at places only a few dozen miles apart. A sounding at station 145 (119°15′ E, 11°10′ S) gave 6300 m. instead of 5000 m. as shown on the map, indicating that probably the Java and Timor deeps form a continuous depression. The "nose" of Borneo near Tg. Mangkalihat continues as a submarine ridge at about 1000 m. until halfway to Celebes; at one spot 600 m. was found, where the map indicated 2000. The exact depths of many "thresholds" were determined in order to elucidate the temperatures and the circulation. Gravity determinations by VENING MEINESZ indicated a possible continuation of the inner Banda ridge towards Sanana, and the soundings confirmed this by detecting a ridge at 3000 m. Several meridional ridges were found in the Molukkian Sea. The Aru and Ceram deeps are parts of one continuous deep, the latter being limited towards the South by a threshold at 1600 m.

In the Banda Sea a new ridge, NE—SW, south of the Lucipara islands is mentioned with a minimum depth of 3100 m. and isolated prominences of 900 and 850 m. south of Ambon and Buru. Southwest of the Sulu islands, folding is suspected in a direction NE—SW, the maximum depth ± 5800 m. being considerably lower than on existing maps.

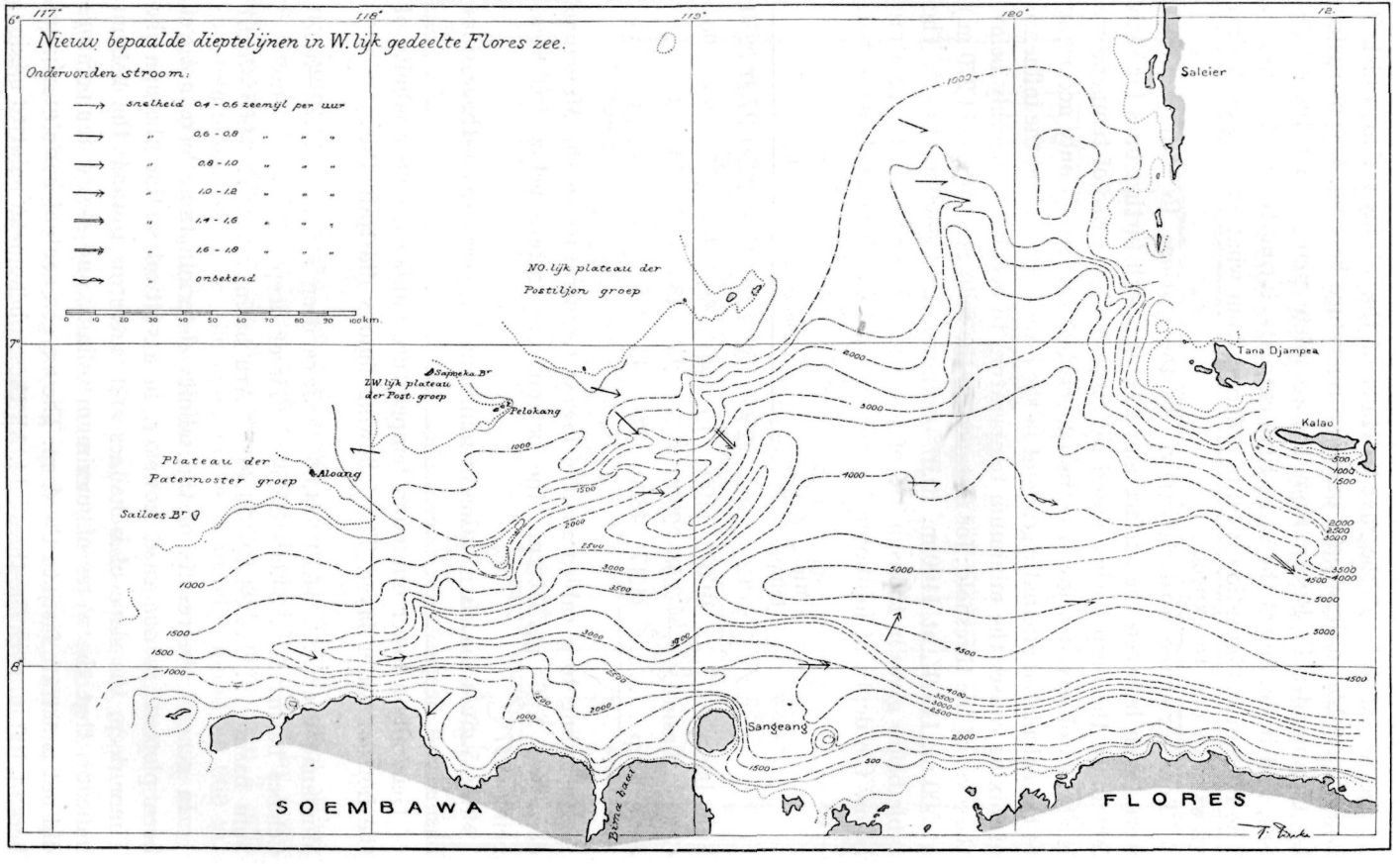

Fig. 4.

As an example of the many details of the configuration which it is now possible to draw on a map, we reproduce here fig. 4, constructed by Commander F. PINKE from the complete material for the Flores Sea, and indicating at the same time currents during the west monsoon. The bottom configuration is quite different from what existing geological views lead one to expect.

Temperature and salinity. At the stations 15 water samples were taken between the surface and 1000 m., with further ones for each 500 m. In the deep basins closed by "thresholds" a rise of temperature is always observed below a certain level, but this rise is only according to the calculated adiabatic gradient in the lowest strata, and the influence of mixing causes the minimum temperature to occur considerably below the level of the threshold; for instance, in the Sulu Sea (threshold 270 m.) at 500 m. 11.00°, at 1100 m. 10.07° (minimum), at 4400 m. 10.51°. The table below gives in thousandths of a degree the increase in temperature below the depth of minimum temperature between the levels indicated.

	Min. temp.	Depth	Depth increased by						
	°C.	m.	250	750	1250	1750	2250	2750	3250
Sulu basin	10.07	1100	15	40	60	65	75	85	90
Celebes basin.....	3.58	2500	5	25	45	65	70	..	..
Java deep	1.17	4300	10	45	55	..	..	..	..

According to a cablegram the lowest temperature in the Mindanao deep was 1.56° at 3500 m., the bottom-temperature below 10,000 m. being 2.47°.

Fig. 5 gives the distribution of minimum temperatures in the various basins and deeps.

Generally a lower minimum temperature implies a higher salinity of the bottom water layer. The following figures illustrate this.

Mindanao deep	34.70—34.66	Java deep	34.72—34.70
Celebes basin.....	34.60—35.54	Timor deep	34.69
Sulu basin	34.49—34.45	Aru basin.....	34.65—34.61

In general the results of the salinity determinations have not yet been plotted; in one case, however, in a vertical section through the Timor deep, the slope of isohalines and isotherms towards the bottom indicates that the water of maximum salinity and lowest temperature did not penetrate far into the deep. The oxygen content has a maximum here at 100 m. over the threshold. All these phenomena point to mixing.

Also the calculation of currents from the densities has not yet been tried in many cases. In the Timor deep the calculation indicated a current between 150 and 250 m. depth towards SE., lying between currents to the W. at the surface and further down.

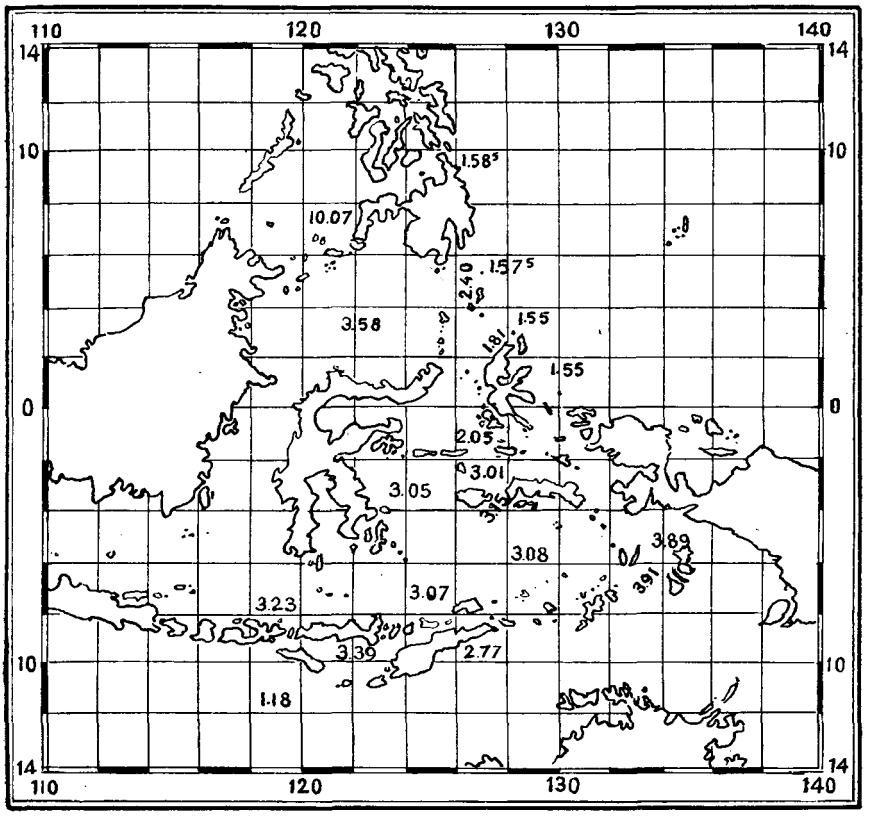

Fig. 5.

Thousands of oxygen determinations have proved of much value in the study of the currents; lack of circulation is indicated by very low oxygen contents in the Sulu sea, in places not more than 2 cc/l. The minimum, which in the open ocean is usually found at 600 m, occurs at various depths in the basins; these depths depend in the same way on the depth of the threshold as that of the minimum temperature.

Current-measurements. Extensive measurements of currents were made in various passages between two basins, extending to 1900 m. depth in Makasser strait, to 1000 m. in Sawu strait, to 1700 m. in the passage between Mangoli and Obi; the measurements were continued

for more than 24 hours, so as to show tidal movements as well as residual currents. In Makasser strait, the strongest current was 83 cm/sec. SSE. at 50 m. depth, as compared with 30 cm. SE. at the surface. At the bottom a very weak current to the N. was found. In Sawu strait tidal influences were evident down to 1000 m.; the residual currents, 30 cm. at the surface, 8 cm. at 50 and 200 m., was 17 at 100 m. and 11 at 1000 m., with very different directions, whereas near the bottom a current of 19 cm/sec appeared strong enough to prevent any deposits.

Near Obi, the residual current had a component towards the North between the surface and 200 m., towards the South at 350 and 500 m. At 1500 m. depth, the current changed in 5 hours from 30 cm/sec. SE. to 17 cm. NW. The residual current is 6 cm/sec. towards SE. Near the bottom, fluctuations of temperature indicated also changeable currents, probably of a turbulent type.

Fluctuations in physical and chemical properties of the sea water. In Makasser strait, Sawu strait and near Obi (station 253a) water samples were taken every two hours for 24 hours at depths extending to 500 or 800 m. Temperature, salinity and oxygen-content showed parallel fluctuations, indicating probably internal waves with a maximum amplitude of 100 m. at station 253a (depth 450 m.), and of 40 m. in Makasser strait (depth 250 m.). In comparison we mention an amplitude of about 20 m. found by DEFANT in the Atlantic Ocean.

Bottom deposits. In addition to the ordinary bottom samples taken during the soundings a special tube of 4 m. length was constructed in order to obtain very long samples of bottom deposits. This device has been very successful, as, for instance, on the slope of the Sabu shelf samples of 102 cm., in the Gulf of Boni even of 174 cm. were obtained, a remarkable length. During the extension of the cruise towards the Mindanao deep a bottom sample of red sea clay of 54 cm. was obtained at a depth of more than 10,000 m., the maximum depth measured by echo sounding being 10,170 m. The most interesting result of the study of the bottom samples is that in the Sulu sea in depths over 4000 m. at stations 64, 65 and 66 deposits appeared to consist mainly of globigerines. This may point to a very slow circulation, but also the alkalinity and p_H may give an explanation, as the former is lower and the latter higher in the Sulu sea, so as to diminish the rate of solution of the calcium carbonate.

We must abstain from mentioning here results bearing on geology and biology; the preliminary reports, however, show that many facts are being collected and that in these respects also important contributions to our knowledge of this interesting area may be expected.