551·465(548)

Ocean currents off Visakhapatnam

C. POORNACHANDRA RAO

Meteorological Office, Poona

(*Received 18 January 1956*)

Neither direct measurements nor indirect calculations of the sub-surface current velocities appear to have been made in the Bay of Bengal in the past. Only a few surface ship drift records are available. In view of this, a study of the currents in the Bay of Bengal was undertaken on one of the several oceanographic cruises arranged by Andhra University with the co-operation of the Defence Ministry. In cruise No. 12, which lasted from 4 to 6 March 1953, temperature and salinity measurements were made at eight serial stations arranged in a section perpendicular to the coast at Visakhapatnam and extending up to 115 miles across the sea. The station locations are shown in Fig. 1. At each station the temperature and salinity of the water was determined at the surface and at a series of different depths to the bottom or 400 metres. From these temperature and salinity data, dynamic heights were obtained from tables (La Fond 1951) and currents at depths 0, 50, 100, 150, 200, 250, 300 metres computed using the expression

$$V = \frac{10\,(\triangle D_A - \triangle D_B)}{L \times 2\,\omega \sin \phi}$$

where, $\triangle D_A - \triangle D_B$ = difference in the anomalies of dynamic height at stations A and B, in dynamic metres

L = distance between stations in metres

V = relative current velocity normal to a line joining the two stations, in metres per second

ω = angular velocity of the earth equal to $0 \cdot 729 \times 10^{-4}$ radians per second

ϕ = mean latitude between stations

The reference levels or assumed layers of no motion were taken as 400 metres. When the depth of water was less than 400 metres the calculated current value at the adjacent pair of stations was extrapolated at the maximum depth common to the shallow station and this was used as the base current to which additional dynamic heights were added or subtracted. This method appears reasonable since the calculated current over the shelf is then 0·5 to 0·8 knots which is in good agreement with average currents determined by ship drift for this season and place (0·7—1·7 kts). An even better agreement may have been obtained if the temperature and salinity observations had extended deeper and the assumed level of no motion taken at a greater depth.

The calculated current distribution with reference to the 400 m level is shown in Fig. 2. The surface and sub-surface ocean currents in the region of the survey are those directed across the station line, *i.e.*, from a general SW to NE direction. The main features of the current distribution concluded from this single survey in March are given below—

(*i*) The surface current was stronger (19 to 23nm/day) at 15, 70 and 165 km from coast.

(*ii*) The maximum surface current (23 nm/day) was at 70 km. This appears to occur just off the continental slope and may be

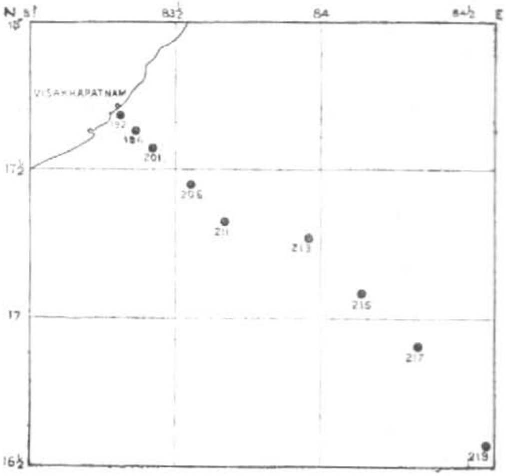

Fig. 1. Location of oceanographic stations off the Visakhapatnam coast where temperature and salinity data were obtained for the calculation of currents

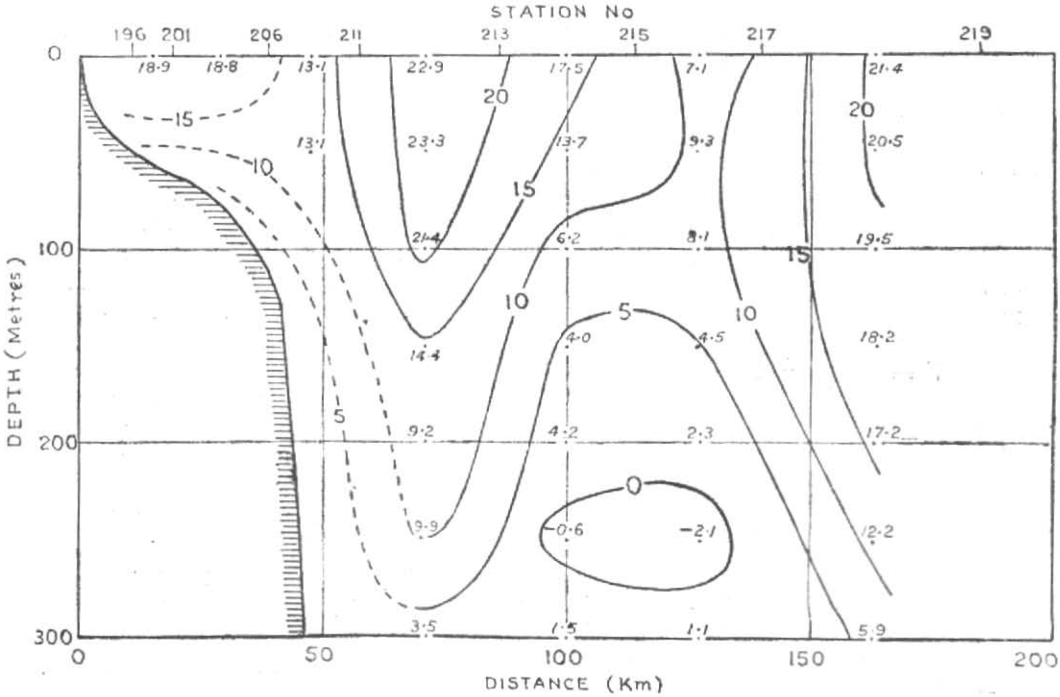

Fig. 2. Calculated surface and sub-surface ocean currents off Visakhapatnam

(Expressed in nautical miles per day across the station line in a general NE direction) associated with an upwelling circulation in this region. From a study of the vertical structures of temperature and salinity in the section perpendicular to the coast it is noticed that there was upwelling near the coast (La Fond 1954). Another high surface current (21 nm/day) was at 165 km.

(*iii*) Corresponding strong sub-surface currents occurred where the surface currents were strong. Thus the current was (*a*) 21 to 23 nm/day at 70 km from the coast down to a depth of 100 metres and (*b*) 17 to 21 nm/day at 165 km from the coast down to a depth of 200 metres.

(*iv*) At depths greater than 150 metres, the current was very weak (less than 5 nm/day) at 100 to 125 km from the coast. It appears to be reversed at a depth of 250 metres. If there is some NE flow at 400 m the reversal may indicate a reduction in speed rather than direction. The surface current in this region was 7 to 18 nm/day.

(*v*) Assuming no motion at 400 metres, the mean current for the area decreases progressively with depth, that is the NE or its component across the station line decreases from 17 nm/day at the surface to 3 nm/day at a depth of 300 metres. The current at a depth of 150 metres calculated to be more than 10 nm/day is relatively strong when compared to most open sea currents.

Although the above is a standard method for determining the deep sea currents the results obtained are subject to certain limitations among which are—

(*i*) The temperature and salinity data at different stations utilised in the current calculations were not simultaneously recorded but taken during a period of three days.

(*ii*) The computed speeds refer to the NE/N component of the currents.

(*iii*) As the data collected were limited to 400 metres depth or less, the assumed layer of no motion refers to 400 metres depth level instead of the conventional 500 metre depth level.

The author wishes to express his indebtedness to Prof. E. C. La Fond for guidance in the work.

REFERENCES

La Fond, E. C. 1951 'Processing Oceanographic Data', U.S. Navy Hydrographic Office.

1954 Andhra University Memoir in Oceanography, **1**, pp. 117-121.