

## Oceanography of Wadge Bank—Current Measurements over a Tidal Cycle Off the South Coast of India

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Direct current measurements made during the onset and termination of SW monsoon indicate wide fluctuations in space and time. The nearshore current decreases in magnitude from the onset to the termination of the monsoon. The resultant surface current over a tidal cycle is observed to flow parallel to the coast directed southeastward off Muttam Point in the Arabian Sea, east to southeastward in the area south of Cape Comorin in the Indian Ocean and northeastward parallel to the coast line in the area off Manappad Point in the Bay of Bengal.

Wadge Bank comprises a shallow zone off the southern tip of the Indian Peninsula, where the bottom topography is almost flat and the continental shelf is very wide compared to the adjoining shelf. As a result of such condition it forms one of the potential zones of fishery<sup>1-4</sup>.

Information on oceanographic conditions of this region is very meagre although some hydrographic information is available<sup>5</sup>. At present there is no detailed information on direct current measurement and also the time variations. Any general information on the current pattern near the coast can never be taken as representative, as the time variations of the current are high. In order to have an idea of the variation of the current pattern in space and time, variations of current over tidal cycle at surface and subsurface levels during the onset (May 1981) and termination (Sept. 1981) of the SW monsoon are studied.

### Materials and Methods

Three stations were selected off the southern coast of India that represent the transition between the Arabian Sea, Indian Ocean and the Bay of Bengal (Fig. 1). The bottom depths at sts 1-3 were 40, 32 and 35 m respectively. These stations were selected with the specific intention of studying the transformation of nearshore current pattern from the Arabian Sea to the Indian Ocean and the Indian Ocean to the Bay of Bengal and where the coast line orientations were entirely different.

Direct current measurements were carried out from anchored R V Gaveshani for 12 h using Plessey direct reading current meter and the Aanderaa recording type current meter at intervals of 1 h during the onset of SW monsoon (19-22 May 1981) covering the sts 1 and 2. During the end of the SW monsoon (19-26 Sept. 1981) current measurements were carried out using the same instruments covering all the 3 stations. Although it was realised that the direct current measurements from an anchored vessel may give rise to errors due to yawing caused by current, wind and also due to drag in the anchor; it was considered that these might be least in shallow water and any information on nearshore current, particularly based on direct measurements would be of importance to fishing craft and other vessels operating in this region.

The current measurements were made at surface, 10, 20 and 30 m depths. The current vectors for each station and at each depth were presented by hodographs (Vector diagrams connected by means of a smooth curve so as to represent the particle motion under the influence of the current). The resultant vector was also represented by an arrow and shown as R in hodographs. To know the relationship between the current and tide, separate figures were drawn showing variations of current magnitude at surface

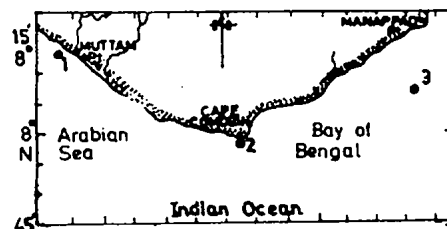


Fig. 1 — Station locations

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and sub-surface levels along with variations of tide levels at Cochin for each station during the same period.

### Results and Discussion

*Currents during May 1981*— Hodographs for sts 1 and 2 representing current variations at the time of onset of SW monsoon (Figs 2 and 3 respectively) indicate the clockwise rotation of current under the influence of the Coriolis force. At st 1, the variation of surface current shows predominant eastward components and the magnitudes vary between 50 and 130  $\text{cm sec}^{-1}$  over a tidal cycle. There are no westward components for the current vectors. At depths of 10 and 20 m the variation of the current over a tidal cycle shows reduced magnitudes (21-99  $\text{cm.sec}^{-1}$  at 10 m and 19-74  $\text{cm.sec}^{-1}$  at 20 m) compared to the surface. At these levels also the flow is predominantly eastward with negligible westward components indicating that the current does not reverse with the change in tide. The resultant current R over the semi-diurnal tidal cycle varies from 75  $\text{cm.sec}^{-1}$  at surface to 52 and 40  $\text{cm.sec}^{-1}$  at 10 and 20 m depth respectively. The resultant current is approximately parallel to the coast line and directed south-eastward. Thus, it appears that the coastal current at st 1 is slightly influenced by the tide. Variations of current magnitudes at surface and subsurface levels with tide for st 1 are shown in Fig. 4A. The general trend of increasing current with rise in tide and decreasing current with fall in tide is noticeable.

Hodographs for st 2 (Fig.3) for surface and subsurface show that the current vectors lie in almost all the 4 quadrants indicating the dominant influence of the tide. The current magnitudes vary from 35 to 110, 15 to 84 and 9 to 50  $\text{cm.sec}^{-1}$  at surface, 10 and 20 m depth respectively over a tidal cycle. The resultant current R has magnitudes of 46, 41 and 14  $\text{cm.sec}^{-1}$  at surface, 10 and 20 m respectively. The resultant current direction also varies from northeastward at surface to northward at 10 m and eastsoutheastward at bottom. At this station also the current speeds increase with increasing tide level (Fig.4B) showing a general trend of current following the tide at all levels. The near shore current flowing parallel to the coast from st 1 to st 2 has decreased in strength at all levels during the onset of SW monsoon.

*Currents during Sept. 1981*— Hodographs for surface, 10, 20 and 30 m at st 1 during monsoon are shown in Fig.5. The current magnitudes vary from 13 to 24, 14 to 22, 11 to 21 and 11 to 23  $\text{cm.sec}^{-1}$  respectively at surface, 10, 20 and 30 m depth over a tidal cycle indicating that the current is considerably weak compared to that at the time of onset of the SW

monsoon. The surface current has eastward and southward components but the subsurface current has components more or less in all directions. The resultant current R has magnitudes of 18, 12, 8 and 7  $\text{cm.sec}^{-1}$  at surface, 10, 20 and 30 m depth respectively. This indicates weakening of the nearshore current from the time of onset of monsoon to its termination. The resultant current R is approximately parallel to the coastline and directed southeastward as in May.

Variations of current magnitude with tide (Fig.4C) indicate that they are more or less steady.

At st 2 the currents vary from 25 to 80, 18 to 54 and 14 to 37  $\text{cm.sec}^{-1}$  at surface, 10 and 20 m depth respectively over a tidal cycle (Fig.6). These values are considerably low compared to those of May 1981. The current at surface has eastward and southward components, at 10 m depth it has components in all directions. The resultant current R has magnitudes of 53, 32 and 19  $\text{cm.sec}^{-1}$  at surface, 10 and 20 m respectively. The resultant current direction is southeastward at surface, eastward at 10 m and northeastward at 20 m depth. Though there is a general trend of decreasing current with fall in tide there is no increasing trend with increase in tide level (Fig. 4D). As such, the tidal influence appears to be less on the nearshore current.

At st 3 the current magnitudes vary from 24 to 55, 27 to 49, 18 to 35 and 23 to 48  $\text{cm.sec}^{-1}$  respectively at surface, 10, 20 and 30 m depth over a tidal cycle (Fig.7). The current at surface and at other depths has components in eastward and northward directions. The resultant current R has magnitudes of 41, 34, 32 and 25  $\text{cm.sec}^{-1}$  at surface, 10, 20 and 30 m depth respectively. It is directed northwestward almost parallel to the coast line.

The variations of current with the tide (Fig.4E) indicate that the current at surface and subsurface levels is rather steady with rising and falling tide. This again points out the lesser influence of the tide on the nearshore current.

During Sept. the nearshore current flowing parallel to the coast from st 1 to st 3 has increased in strength at all depths.

Thus, it is observed that the direct current measurements in the nearshore environment exhibit wide fluctuations in space and time. The nearshore current decreases in magnitude from the onset to the end of the SW monsoon. The resultant surface current over a tidal cycle is observed to flow parallel to the coast directed southeastward at st 1 in the Arabian Sea, east to southeastward at st 2 in the Indian Ocean and northeastward at st 3 in the Bay of Bengal under the influence of the predominant SW winds and tides.

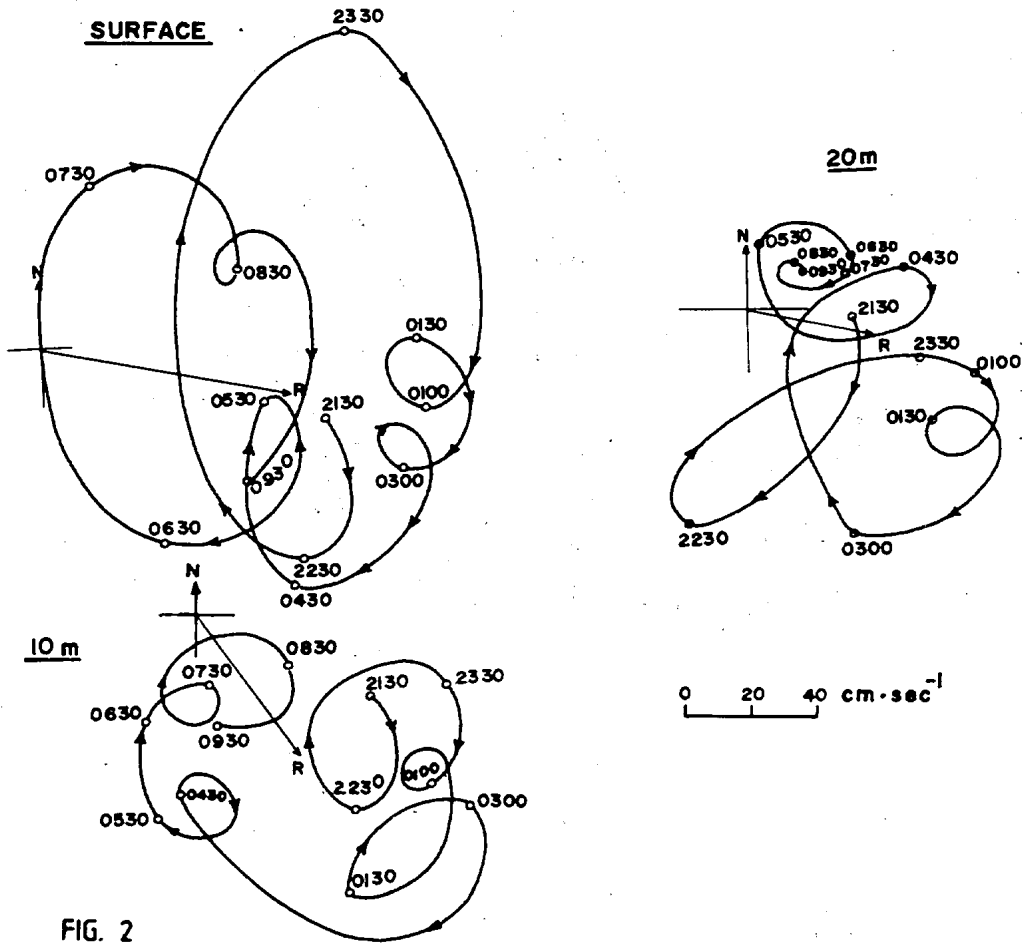


FIG. 2

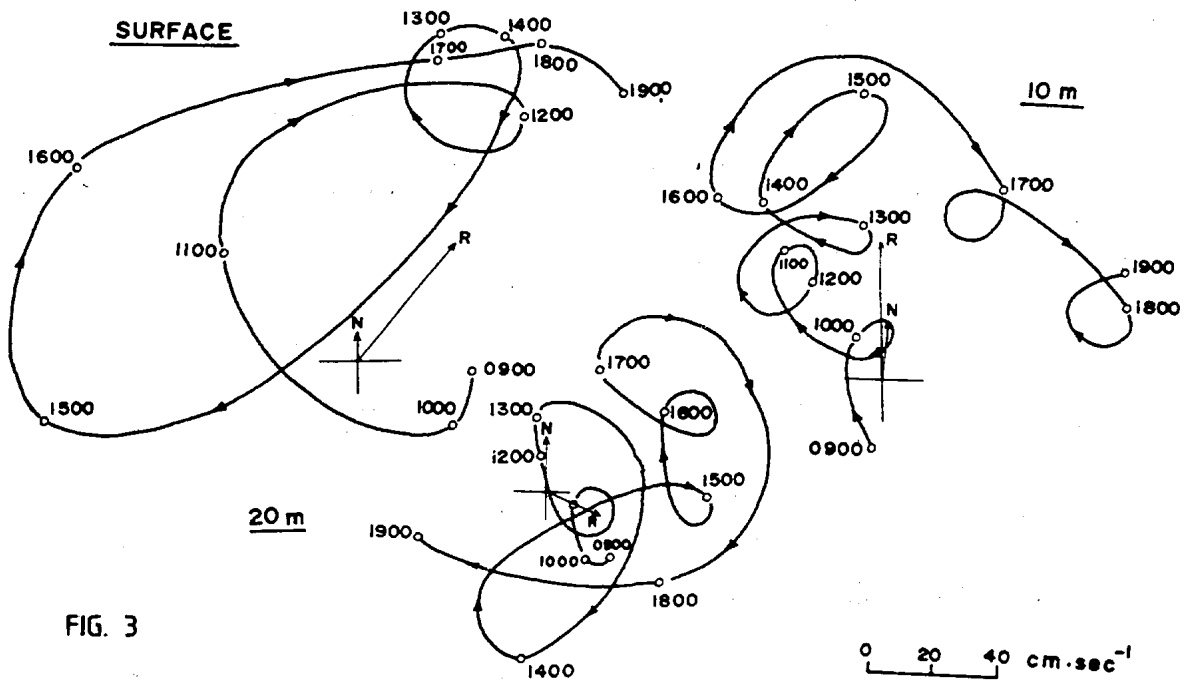


FIG. 3

Figs 2 and 3—Hodographs respectively of st 1 during 19-20 May 1981 and st 2 on 22 May 1981 at surface, 10 and 20 m depths

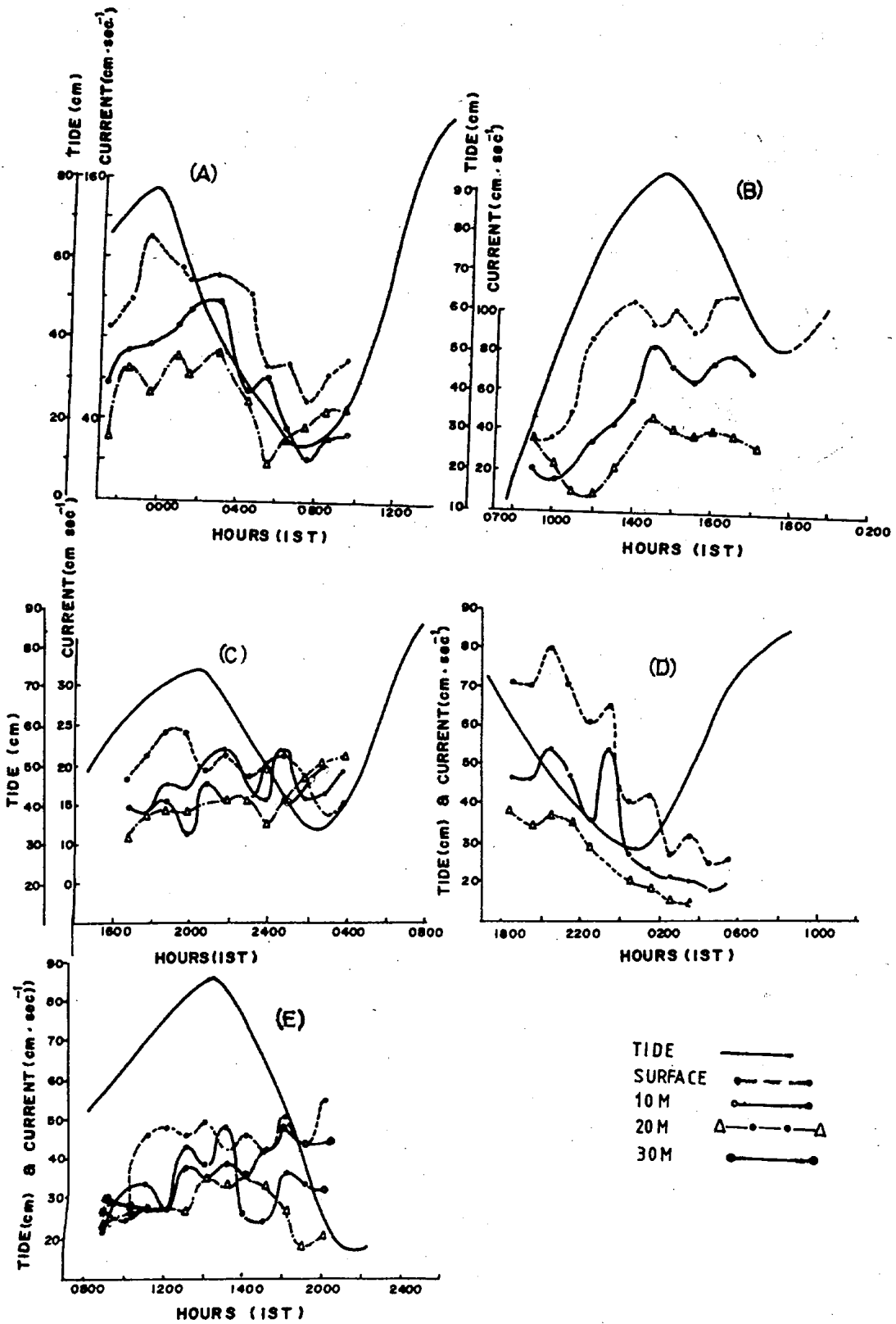


Fig. 4— Variation of current and tide over a tidal cycle at A) st 1, 19-20 May 1981; B) at st 2, 22nd May 1981; C) st 1, 25-26 Sept.1981; D) st 2, 22-23 Sept.1981; E) st 3, 19th Sept.1981

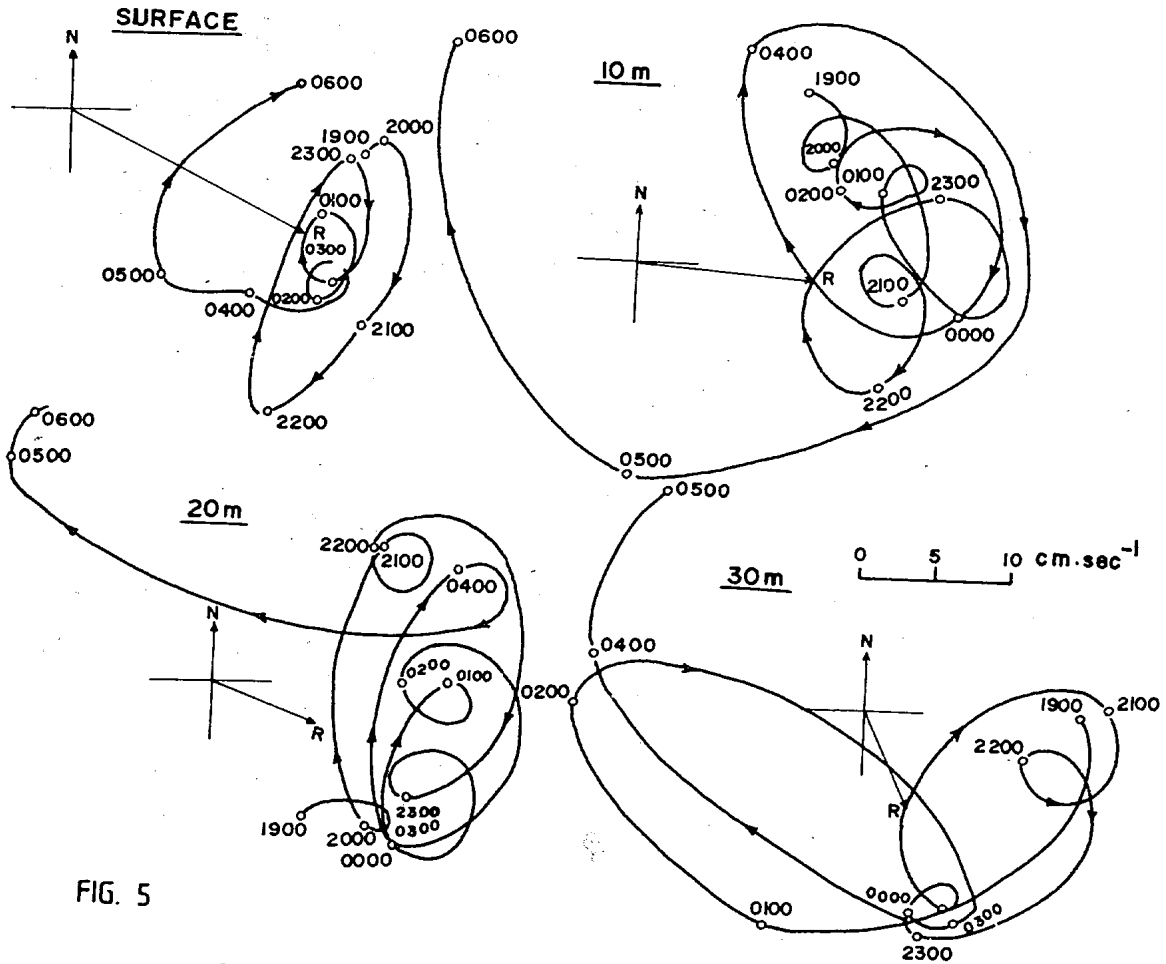


FIG. 5

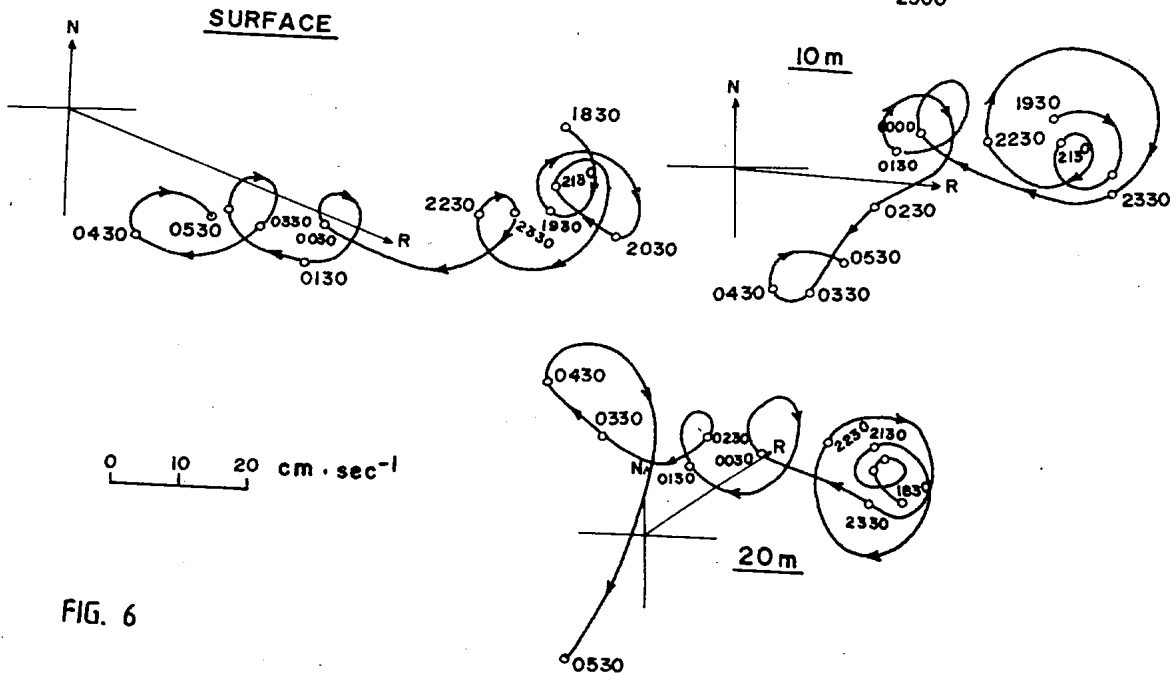


FIG. 6

Fig. 5— Hodographs of st 1, 25-26 Sept. 1981 at surface, 10, 20 and 30 m

Fig. 6— Hodographs of st 2, 22-23 Sept. 1981 at surface, 10 and 20 m

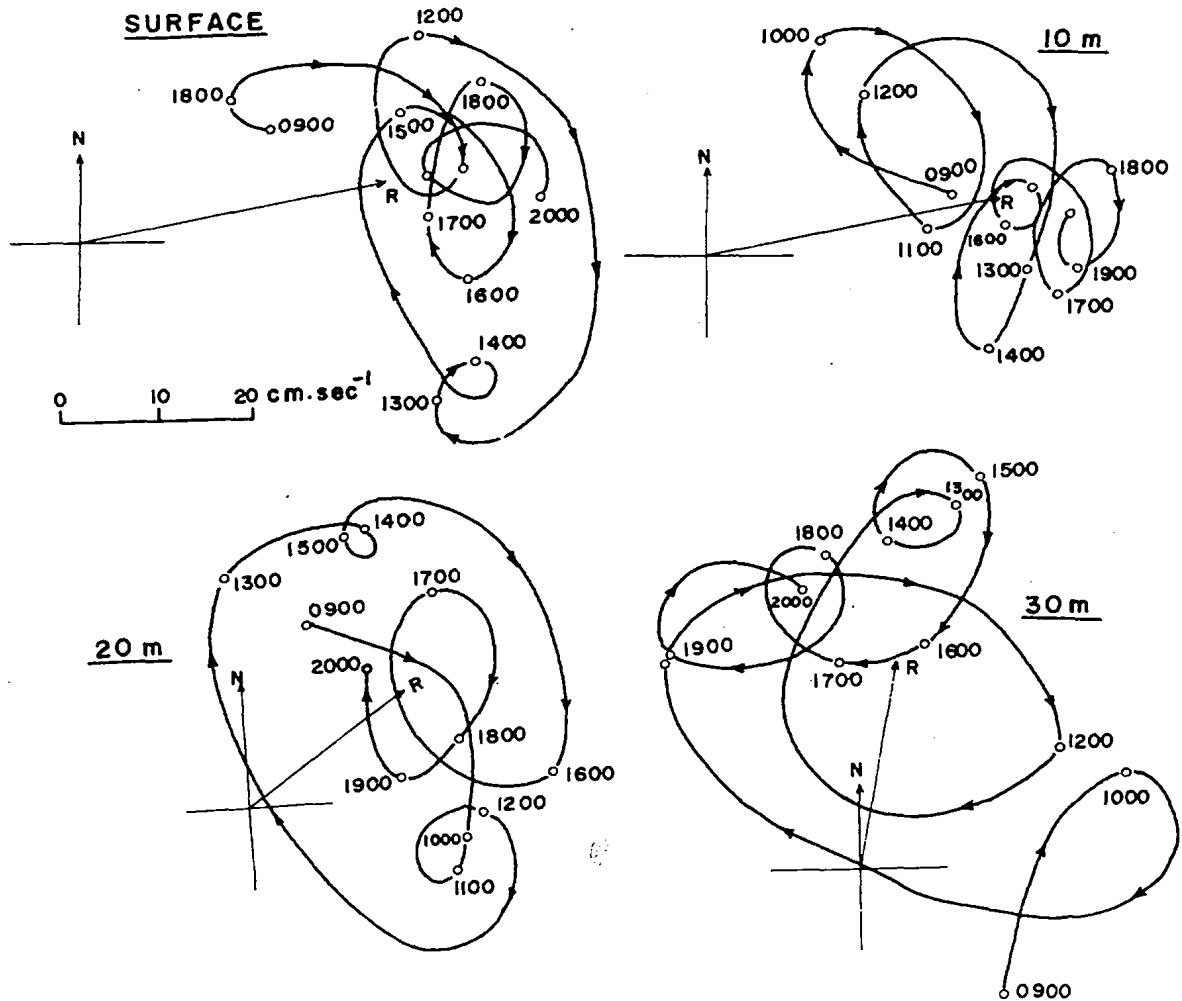


Fig. 7.— Hodographs of st 3, 19th Sept 1981 at surface, 10, 20 and 30 m

The nearshore current (Fig.4) exhibits a 2 to 4 h oscillations in magnitudes. An anchored vessel sways across and in the direction of the surface current apart from the drag it suffers. The 2 and 4 h oscillations may be related to these movements which needs further survey.

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