SPECIAL ARTICLES

OCEAN-BOTTOM CURRENTS OFF THE CALIFORNIA COAST*

THE existence of appreciable currents at great depths in the open sea has been demonstrated by Norwegian and German oceanographers[1] through measurements made from anchored ships. These observations, however, were usually carried out at distances of several hundred meters above the ocean bottom. Recently Stetson[2] has measured velocities near the sea floor in the submarine canyons off the New England coast, using a device which allowed him to suspend a current meter within 28 centimeters of the bottom. He obtained velocities up to 11 centimeters a second and interpreted these movements as tidal manifestations.

During the past year the writers have made many series of bottom current measurements, including approximately 200 individual observations. In much of this work a tripod designed by C. I. Johnson and Revelle[3] has been used to suspend an Ekman current meter at distances between 125 and 20 centimeters above the ocean bed. The observations have been made in six submarine canyons at depths ranging from 42 to 840 meters; on an open continental shelf at 73 meters; on a straight steeply sloping submarine scarp at a depth of 375 meters; on a 760-meter saddle between two basins; and in a comparatively shallow-rimmed basin at a depth of about 890 meters. Observations over time intervals of five to fifteen minutes were made as rapidly as possible for periods between 8 and 35 hours in the submarine canyons and for 20 hours on the continental shelf.

The results of this work were largely unexpected. While the full significance of the observations can be determined only by further investigation, some preliminary conclusions appear to be warranted from the available data. Thus it may be seen from Table 1 that the maximum velocities of these bottom currents are of the same order of magnitude as that of most surface currents in the open sea. The velocities are, however, not comparable with those found in rivers on land nor in narrow tidal passages, since they do not exceed 37 centimeters per second (0.7 nautical miles per hour). The maximum current velocities observed in deep water were as high as those found in shallow water. The observations do not show any significant relationship between maximum current velocities and the different types of bottom topography, nor is there evidence to indicate that the currents are stronger where the bottom is sandy or rocky. It is possible, however, that such relationships might be revealed if a sufficiently long series of observations were available from several localities.

Where observations were continued for a considerable period, it became evident that both the speeds and directions of the currents were constantly shifting (Fig. 1). A considerable number of observations

* Contributions from the Scripps Institution of Oceanography, New Series No. 53.

1 B. Helland-Hansen, "Michael Sars North Atlantic Deep Sea Exped., Scientific Results," Vol. 1, pt. 2, pp. 106–113, 1930. A. Defant, "Wiss. Ergeb. d. Deutschen Atlantischen Exped. auf dem Forschungschiff *Meteor*," 1925–1927. Bd. 7, 1932.

2 H. C. Stetson, *Trans. Am. Geoph. Union for 1937*, pp. 216–219.

3 R. H. Fleming and Roger Revelle, "Current velocity profiles near the sea bottom." To be submitted to the *Journal of Marine Research.*

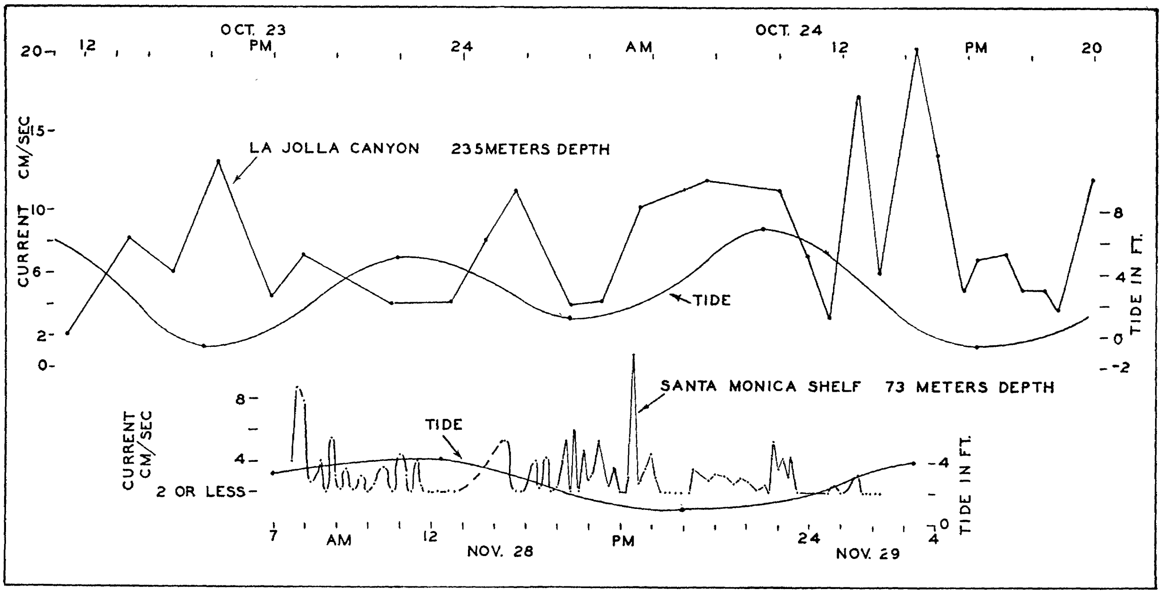

FIG. 1. Observed current speeds in La Jolla submarine canyon and on the continental shelf off Santa Monica, measured at a height of 125 centimeters above the bottom.

TABLE I

MAXIMUM OBSERVED BOTTOM VELOCITIES AT VARIOUS LOCALITIES

Depth meters	Maximum velocity cm/sec.	Submarine topographic feature	Nature of bottom	Number of observations
42	7.3	La Jolla Canyon	Silty sand (thin cover)	14
58	10.6	Newport Canyon	Black mud	15
73	10.7	Santa Monica Shelf	Silty sand and rock	80
91	26.9	Monterey Canyon	Sandy silt (thin cover)	16
182	14.7	Scripps Canyon		6
235	20.4	La Jolla Canyon	Silty sand	31
375	36.7	Scarp off San Pedro hill	Sandy silt	6
560	23.0	La Jolla Canyon	Silty sand	6
759	8.8	Saddle near San Clemente Island	Glauconitic and calcareous sand	2
780	18.8	San Pedro Canyon		1
796	20.8	Coronado Canyon	Mud	4
840	8.0	San Pedro Canyon	Rock and sand	3
886	17.7	San Pedro Basin	Silty mud over sand	3

showed the absence of a velocity strong enough to make a record (less than 2 or 3 cms per second). Such periods were occasionally followed by some of the highest measured velocities. In the submarine canyons the observed directions of movement showed a tendency to follow the axes of the canyons, but shifts in direction from up to down canyon occurred at irregular intervals. The bottom currents thus appear to be non-tidal in character, although they exhibit some tidal components. Even on the continental shelf where tidal components might be expected to predominate, non-periodic changes in velocity were encountered.

The observed irregular movements of the bottom water probably can be best interpreted as indicating the presence of large moving eddies with vertical axes.[4] The presence of silts and muds on the bottom in certain areas of highest observed currents indicates that these eddy currents are not competent to prevent all deposition. Nevertheless, such currents must play an important part in the transportation of fine sediment along the sea floor. Since evenly distributed eddies can not alone produce any net transport, however, other factors such as the gravitational component down slope and residual currents must cooperate to prevent deposition on the many areas of hard bottom off the California coast. Possibly, also, the currents are not as competent to move debris as might be expected from observations on the transporting power of rivers, since it is probable that velocities decrease more rapidly near the sea bottom[5] than near the bottoms of rivers.[6]

These bottom currents may be looked on as part of a mechanism for carrying sedimentary material, brought into the ocean by floods or by wave erosion, out into considerable depths of water. This transporting ability, however, should not be thought of as equivalent to cutting power sufficient to erode great submarine canyons out of the rock of the ocean bottom.

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[4] C.-G. Rossby, *Jour. Marine Research,* 1: 3, 239–262, 1938.

[5] Fleming and Revelle, *ibid.*

[6] W. W. Rubey, *U.S.G.S. Professional Paper* 189E, p. 132, 1938.

INHIBITION OF GASTRIC SECRETION BY EXTRACTS OF NORMAL MALE URINE[1]

IT is a well-established fact that gastric secretion and motility are inhibited by the ingestion of fat. That the inhibition is mediated humorally was proved in 1926 by Farrell and Ivy,[2] who found that the oral administration of fat inhibits motor activity in the transplanted and denervated gastric pouch. Feng, Hou and Lim[3] subsequently demonstrated that fat also inhibits secretory activity of the transplanted gastric pouch. Quigley, Zettleman and Ivy[4] showed that sugars likewise inhibit gastric motility by a humoral mechanism. It has been demonstrated that the humoral agent is not fat or one of its products of digestion, nor a constituent of thoracic duct lymph. Bile and the duodenal hormones, secretin and cholecystokinin, have also been eliminated from consideration.[3, 4] Evidence that the humoral agent is a specific duodenal chalone was proved by Lim and his coworkers,[5] who, after finding that a preparation of duodenal mucosa provided by Ivy inhibited gastric secretion, successfully prepared extracts of the duodenal mucosa which inhibited gastric secretion and motility. The active principle was given the name enterogastrone. Gray, Bradley and Ivy[6] later prepared more potent extracts of enterogastrone and defined a tentative unit based on the degree of inhibition of gastric secretion in dogs.

Although we have previously believed that both motor and secretory inhibition were produced by one

[1] Aided in part by a grant from the Committee on Endocrinology of the National Research Council.

[2] J. I. Farrell and A. C. Ivy, *Am. Jour. Physiol.,* 76, 227, 1926.

[3] T. Feng, H. Hou and R. K. S. Lim, *Chin. Jour. Physiol.,* 3: 371, 1929.

[4] J. P. Quigley, H. J. Zettleman and A. C. Ivy, *Am. Jour. Physiol.,* 108: 643, 1934.

[5] T. Kosaka and R. K. S. Lim, *Chin. Jour. Physiol.,* 4: 213, 1930; *ibid.,* 7: 5, 1933; R. K. S. Lim, S. M. Ling and A. C. Liu, *ibid.,* 8: 219, 1934.

[6] J. S. Gray, W. B. Bradley and A. C. Ivy, *Am. Jour. Physiol.,* 118: 463, 1937.