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Inner Shelf Dynamics on a Storm-Dominated Coast, East Coromandel, New Zealand

B.E. Bradshaw[†], T.R. Healy[†], P.M. Dell[‡a], and W.M. Bolstad[*]

[†]Department of Earth Sciences
University of Waikato
Hamilton, New Zealand

[‡]Hauraki Catchment Board
Te Aroha, New Zealand

[*]Department of Mathematics & Statistics
University of Waikato
Hamilton, New Zealand

ABSTRACT

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Initial observations of the coastal oceanography on the east Coromandel inner shelf, northeast New Zealand, were examined using the combined results of sea-bed drifter experiments and Aanderaa continuous recording current meter records. The inner shelf at this location is fairly narrow, ranging from 20–30 km out to the 200 m bathymetric contour.

Near bottom currents in the study area are characterized by two shore-parallel flows. During calm weather, a relatively weak current flows to the south at speeds of between 0.10–0.20 ms^{-1}. This appears to be a remotely forced bottom current possibly associated with the southward directed East Auckland Current. Episodic storm events associated with cyclonic depressions result in the generation of a strong northerly flowing current, with speeds of up to 0.40 ms^{-1} recorded. This is a local wind-generated bottom current, and probably represents part of a more complex 3-dimensional circulation associated with downwelling conditions.

From consideration of current and combined wave-current dynamics, potential long-shelf sediment transport pathways were found to be directed to the north during episodic storm events. Such high magnitude wind events are concentrated during winter and spring each year and occurred relatively infrequently (0.5%–6% p.a.) during the study.

ADDITIONAL INDEX WORDS: *Sea-bed drifters, East Auckland Current, wind-generated current, downwelling, sediment transport.*

INTRODUCTION

CARTER and HEATH (1975) have described New Zealand continental shelves as generally dominated by the effects of storm-generated flows. Shelf tidal currents are considered to be dominant only in the Cook and Foveaux Straits and around North and East Cape. However, along most of the remaining New Zealand coastline, researchers such as HEATH (1978), KIBBLEWHITE *et al.* (1982) and DELL (1983) have found wind-generated currents dominating inner shelf flow patterns.

The east Coromandel shoreline on the northeast coast of New Zealand (Figure 1) is one of the most popular holiday locations in the North Island. Increasing pressure through development of the coast has led to localized erosion problems since the 1970's. Studies dealing with these problems on a regional scale were subsequently undertaken (CHRISTOPHERSEN, 1977; HARRAY and HEALY, 1978; McLEAN, 1979; WILLOUGHBY, 1981; HEALY, 1981; HEALY *et al.*, 1981; HEALY and DELL, 1982, 1987) and identified most beaches as "bayhead" and "pocket" beaches with closed sedimentary systems, receiving little in the way of sand from either rivers or a regional littoral drift.

However, one question which remained unresolved was the importance of the inner shelf as either a potential sink or source for beach sands. This possibility was the basis for the east Coromandel inner shelf study which commenced in 1985.

The purpose of this paper is to present some initial observations from that study on the inner shelf currents of the east Coromandel coast, based on the results of combined sea-bed drifter and Aanderaa continuous recording current meter experiments. Results of the study possess global significance as an example of the dynamics of a lee shelf in a mid-latitude zone of dominant westerly winds.

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[a]*Present address: Bay of Plenty Regional Council, Whakatane, New Zealand*

SHELF SETTING

The east Coromandel coastline is located on an active margin between the Australian and Pacific Plates, and shows aspects similar to a typical collision coast in the classification scheme of INMAN and NORDSTROM (1971). Physiographically, the area forms part of the Coromandel peninsula, an uplifted horst block feature downtilted to the east and composed of Tertiary volcanics overlying an indurated Jurassic sedimentary basement (SKINNER, 1976). The coastline is steep and rocky and indented by numerous small embayments and pocket beaches which front a relatively narrow continental shelf approximately 20–30 km in width. Offshore islands, such as Slipper Island, are often located close to the shoreline and punctuate the regularity of the shelf (Figure 1).

Preliminary investigations of the shelf by DELL *et al.* (1985) have reported a sharp change from rippled fine sands to mega-rippled medium and coarse sands at about 30 m water depth, denoting the nearshore boundary of the inner shelf. At about 50 m water depth the inner to mid shelf boundary is indicated by the increasing proportion of mud appearing in surficial sediments.

Tidal measurements at Whitianga Harbour by SMITH (1980) have found them to be semidiurnal and microtidal with a maximum spring range of 1.62 m. Spring tidal currents have also been measured along the east Coromandel shelf by HARRIS *et al.* (1983) at average speeds of 0.13 ms^{-1}. Studies of wave rider data from Bream Bay by PEEK (1979) have found that average significant wave height along the east coast is low ($H_{1/3} = 0.4$ m, $T = 8$ s), but tends to vary considerably within a short period of time, where intervals of low wave energy are interrupted episodically by storms producing waves in excess of 3 m height. The coast would therefore fit into the wave dominated category according to the DAVIS and HAYES (1984) classification.

The study area is subject to a temperate climate characterized by high spasmodic rainfall (1500–1800 mm p.a.) throughout the year. Winds along the east coast are predominantly low speed west and southwesterlies associated with the passage of mid-latitude anticyclones. High speed onshore-directed east and northeasterly winds occur intermittently and are associated with the infrequent passage (10–20 p.a.) of subtropical low pressure systems referred to as Tasman Depressions. Decaying tropical cyclones such as Cyclone Bola in 1988 will also occasionally impinge into the study area.

Investigations of ocean waters on the east coast by BRODIE (1960) and BARKER and KIBBLEWHITE (1965) have shown the presence of a southward directed geostrophic flow, the East Auckland Current. This current represents part of the easterly flow of the South Pacific Gyre and is fed by the Tasman Front which is ultimately derived from the East Australian Current (STANTON, 1981; HEATH, 1985). After being deflected around the northern tip of New Zealand, the current flows southeast along the continental slope and around the Bay of Plenty. Surveys of the current by DENHAM *et al.* (1985) have shown it to be highly variable, both spatially and temporally.

METHODS

In order to determine the regional inner shelf current patterns of the east Coromandel coast, both sea-bed drifters and Aanderaa continuous recording current meters were utilized. The investigation was concentrated on the segment of coast between Waihi Beach and Mercury Bay (Figure 1).

Sea-bed drifter experiments were conducted over an 18 month period (June 1985 to November 1986) to provide an overview of the regional current patterns. Aanderaa current meters provided detailed measurements at a specific location (Onemana) over the first 6 months of the sea-bed drifter experiment. To determine the relationship between observed current patterns and the local wind regime, an anemograph was set-up just south of Onemana on the frontal dune at Whiritoa and operated continuously throughout the 18 month experiment period (except in June 1985 when wind records were available only from Mt. Drury at Tauranga, some 30 km south). Through integrating the sea-bed drifter and Aanderaa current meter data, it was hoped to gain an understanding of inner shelf current patterns.

Sea-bed Drifters

Sea-bed drifters were chosen in this investigation as they have proved to be a reliable and

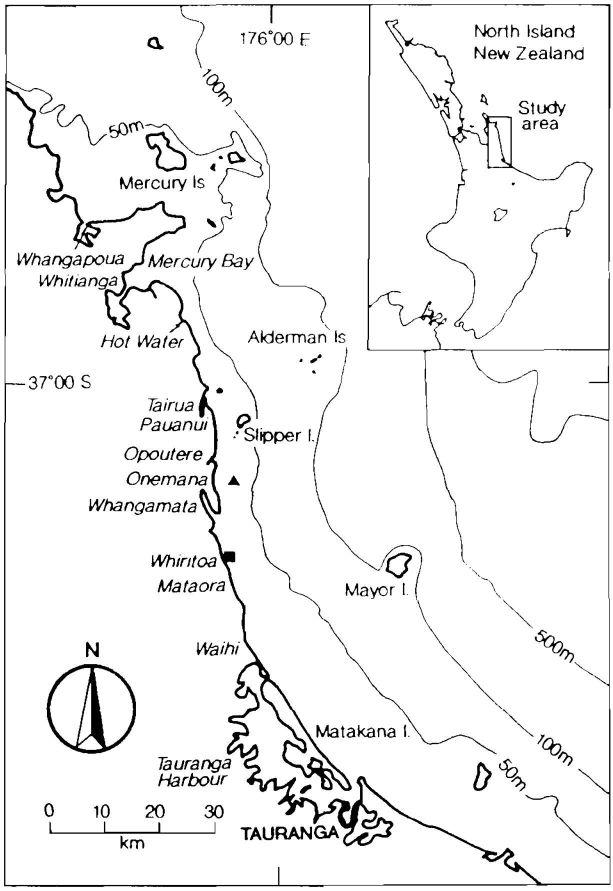

Figure 1. Location map of the east Coromandel study area.

inexpensive means of determining residual bottom current patterns in numerous studies (*e.g.* PHILLIPS, 1970; BARTOLINI and PRANZINI, 1977; GREGORY, 1979). HAMMOND and WALLACE (1982) point out, however, that interpretation from sea-bed drifters are limited to the assumption that the path travelled is in a straight line from the release to recovery point, and problems also arise in relating the drifter speed to that of the current (PHILLIPS, 1970).

Sea-bed drifters used in this study were similar to those originally designed by WOODHEAD and LEE (1960). This consists of an orange polythene saucer, 19 cm in diameter, to which is attached a 54 cm long solid polyvinyl stem with a copper weight at its lower end.

A total of 1000 drifters were released in four experiments between June 1985 and November 1986. These were wrapped in bundles of 50–100 and dispersed on the sea floor by divers. Details of the release and recovery of drifters is shown in Table 1. During the first two experiments in June and July 1985, drifters were released at Whiritoa, Whangamata and Onemana in depths ranging from 10–33 m. The third and fourth experiments were conducted one year later in July and November 1986, drifters only being released at Whangamata in 17, 22 and 27 m water depth.

Table 1. *Details of the release and retrieval of sea-bed drifters.*

Expt No.	Release Date	Location	Depth (M)	No. Released	No.Retrieved	Retrieval (%)	Ave. Days to Retrieve
	6/6/85	Onemana	10–12	50	8	16	28
1	6/6/85	Whangamata	10–12	50	27	54	8
	6/6/85	Whiritoa	10–12	50	13	26	16
	6/7/85	Onemana	12	50	12	24	32
	6/7/85	Onemana	15	50	15	30	21
2	6/7/85	Whangamata	33	50	9	18	47
	6/7/85	Whangamata	15	50	11	22	42
	6/7/85	Whiritoa	30	50	7	14	63
	6/7/85	Whiritoa	22–24	50	10	20	67
	27/7/86	Whangamata	27	100	29	29	29
3	27/7/86	Whangamata	22	100	20	20	27
	27/7/86	Whangamata	17	100	27	27	27
	29/11/86	Whangamata	27	100	15	15	56
4	29/11/86	Whangamata	22	100	20	20	61
	29/11/86	Whangamata	17	50	14	28	48

Retrieval was by the general public, the finder asked to complete a numbered card attached to the drifter giving details as to the exact time and location of retrieval, and requesting the finder to return the card upon completion.

Aanderaa Current Meter

The required detailed near-bottom current data for this study was gathered through use of a standard Aanderaa RCM-4 Eulerian continuous recording current meter. With this type of current meter, speed is measured by a savonious rotor and interval averaged every hour to ± 0.01 ms^{-1} resolution. Direction is measured instantaneously every hour with a magnetic compass to $\pm 5°$, adjustments being made for magnetic variance. The current meter can also record water temperature to $\pm 0.2‰$C and conductivity (salinity) to $\pm 0.1‰$.

As only a standard RCM-4 current meter was used, the main possible source of error in the current measurements arises from wave pumping. BELL *et al.* (1988) have found that in shallow coastal waters (<40 m) this type of current meter can give inaccurate speed recordings during storm wave conditions. However, VINCENT *et al.* (1981) on the Long Island shelf in North America found wave pumping only caused significant errors in shallow waters at low mean current speeds of 0.10 ms^{-1}. As the current meter was located in 27 m water depth, wave pumping should not have caused significant errors during calm periods of the experiment.

Due to limited resources available, only one site could be used. This was located offshore from Onemana at a depth of 27 m. Onemana was considered the best location for the current meter as the inner shelf here appears representative of the east Coromandel coast, with no major harbours or offshore islands present to modify current flows.

Two current meters were deployed, the first (No. 69236) from 6-Jun-85 to 8-Sep-85, which was then replaced by another meter (No. 72046) that operated until 11-Dec-85. The meters were lowered on site from the ship deck, and deployed at 1 m above the sea floor. At 1 m above the sea floor the occurrence of mooring motions on the current records during waves will be small, leaving just the rotor pumping as the main error source.

SEA-BED DRIFTER RESULTS

Retrieval Rates and Interpretation

Retrieval rates of the sea-bed drifters are shown in Table 1. These are generally good compared to similar studies by BARTOLINI and PRANZINI (1977) and MARSDEN (1979), ranging from 14% to 54% and averaging 24% of drifters released. However, factors affecting retrieval rates of drifters need to be briefly considered to determine how representative the dispersal patterns were of the regional current patterns.

BARTOLINI and PRANZINI (1977) and MARSDEN (1979) have described factors affecting the retrieval rates of drifters as including population along the coastline, distance travelled from release site, time at sea and prevailing sea conditions.

In this study public access to the coastline was found to influence retrieval rates. Remote locations such as offshore islands showed lower returns and longer times to retrieve drifters. However, as much of the east Coromandel coast is regularly visited by the public due to its recreational popularity, this factor should not have severely hindered or biased the results.

Distance travelled by the drifters seemed to be an important factor. Retrieval rates decreased over progressively greater distances travelled, particularly within the first 10 km. This is probably because of the high number of drifters that were moved short distances onshore by wave action from their release sites.

Time at sea appeared to affect retrieval rates. In general, the longer drifters remained at sea the lower was the likelihood of recovering them. This would seem reasonable as the longer they remained at sea, the increased chance of being lost offshore into deep water, onshore into estuaries, through sediment burial and kelp snagging on the shelf, or from arrival at a remote location.

Prevailing sea conditions did not seem to directly affect the recovery of drifters, although it probably influenced the distance travelled and time at sea. An additional factor found in this study was the release depth of drifters. This can be seen in Table 1 with shallower release sites in general associated with higher retrieval rates. Again, this trend probably resulted from drifters released in shallower waters being moved directly onshore by wave action.

Residual Current Patterns

Residual current data collected in the four drifter experiments is presented in Table 2. This shows information on the major near bottom current patterns based on the direction drifters were displaced, and on the relative strengths of these currents from the drifters average distance travelled and their net speeds (calculated by distance and time at sea).

The overall direction of drifter movement was both north and south in the first three experiments, and dominantly to the north in the fourth experiment. Although drifters were found to move directly onshore from shallower release sites (10–12 m), significant onshore movement was only observed at Whangamata in the first and third experiments. Therefore, the major current patterns appear to be shore-parallel northerly and southerly flowing currents (northerly flowing meaning a current flowing to the north and southerly to the south). A third minor current branching off the main northerly flowing one just south of Slipper Island may also be present, although much evidence for this comes from retrievals of drifters from the southern waters of Slipper Island by fishing trawlers. These observations are consistent with currents noted on hydrographic charts published by the Royal New Zealand Navy.

From observations of the number of days to retrieve drifters along the coast, it appeared that when either the northerly or southerly flowing currents were present, they would dominate for periods of between 10–15 days before reversing to the opposite direction. The trend was usually for a progressive increase in the number of days for retrieval either north or south, indicating a steady dominant current in one direction.

Of the two alongshore flow directions, the northerly one seems to have been the strongest, based on the consistently higher speed and displacement values shown in each experiment. The southerly flow was only present in the first three experiments, and appeared to be significantly weaker than its northerly flowing counterpart.

Some seasonality in the drifter retrieval patterns was apparent, stronger northerly and southerly flows dominating in winter, but only a relatively weaker northerly flow observed in summer. A relationship between wind and dispersal patterns was observable which is summarized in Figure 2.

The strongest relationship was found between the northerly flow and high speed onshore winds (>7 ms^{-1}) from the east and northeast (Figure 2a). It is possible that the observed trend of a stronger northerly flow in

Table 2. *Results from the four bottom drifter experiments.*

Exp No	Direction Drifters Moved			Ave. Dist Travelled (km)			Ave. Net Speed (km/day)		
	North	South	Onshore	Mean	North	South	Mean	North	South
1	35%	33%	32%	7.7	17.6	3.3	0.45	0.65	0.24
2	57%	30.6%	12.4%	23.5	26.9	10.7	0.52	0.47	0.29
3	35.6%	21.2%	43.2%	8.9	11.8	15.7	0.32	0.39	0.49
4	93.7%	0%	6.3%	12.6	13.0	0	0.24	0.24	0.00

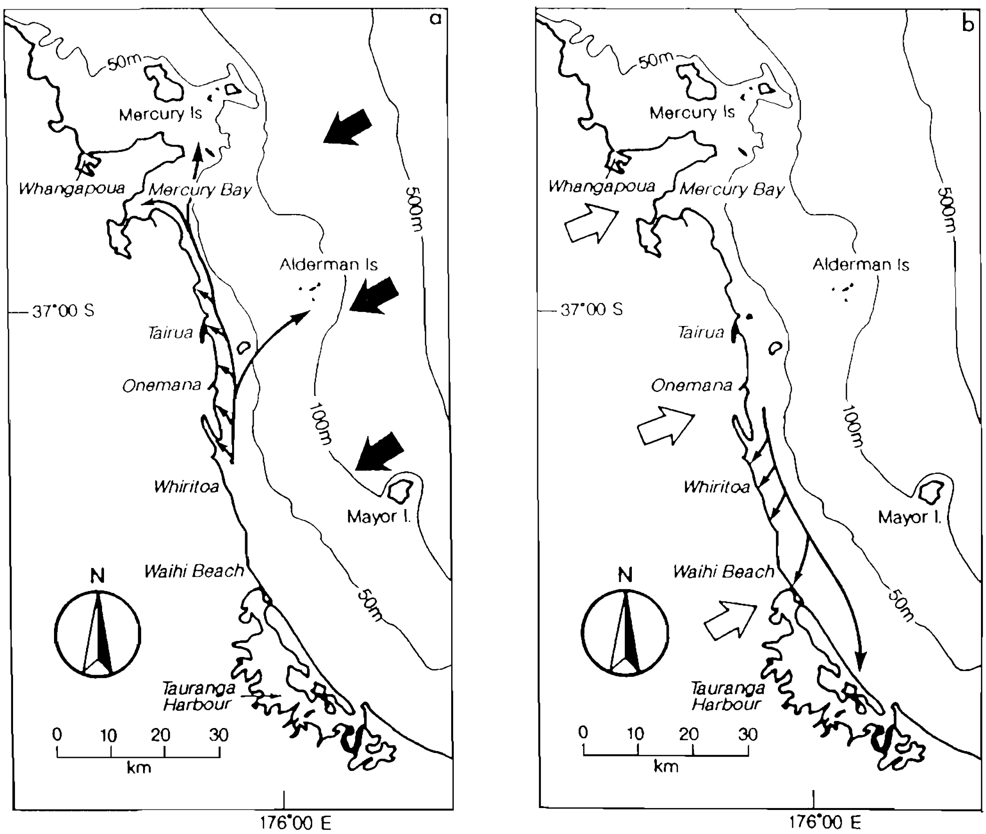

Figure 2. Observed relationship between drifter dispersal patterns (small arrows) and local wind climate (large arrows): (a) northward movement associated with strong easterly winds; (b) southward movement associated with weak westerly winds.

winter and spring coincides with the onshore winds reaching their maximum speeds during these periods.

Although there seemed to be some relationship between low speed offshore winds from the west and southwest and the southerly flow (Figure 2b), the apparent absence of a southerly flow during the fourth experiment, despite the presence of these offshore winds, suggests local meteorological conditions may not be entirely responsible for its generation.

From observations of the number of drifters retrieved at each location during the four experiments, the beaches that consistently showed the highest overall returns of drifters were Whangamata (30.5%), Opoutere (19.6%) and Pauanui (8.8%). This is an important observation as it indicates that conditions within these embayments were consistently favorable for the ultimate onshore movement of drifters. These locations are all on beaches adjacent to major estuary systems along the coastline, and the pattern may therefore be due to either tidal currents transporting the drifters onshore, or shore-parallel currents diverging into the embayments associated with these harbours where wave-induced currents could then transport them onshore. Sections of the above beaches were observed by HEALY and DELL (1987) to be presently accreting, and it is therefore possible that inner shelf sediments are being transported onshore in these locations.

AANDERAA CURRENT METER RESULTS

Current Meter and Anemograph Records

Initial examination of the Aanderaa current records showed no obvious semi-diurnal variations in current speed or direction, and so it was assumed that tidal currents were of minor importance to the mean inner shelf circulation of the study area. Therefore, only the low frequency current and wind oscillations (*i.e.* > 24 hours) were evaluated. For this, daily averages from the raw hourly Aanderaa current meter and Anemograph records were obtained by breaking the data into 45° quadrants (*i.e.* N, NE, E, *etc.*) and then calculating the resultant current or wind components in both the west-east (R_x) and south-north (R_y) directions, according to the formula outlined by PANOFSKY and BRIER (1968):

$$R_x = \frac{\Sigma W - \Sigma E + .707(\Sigma SW + \Sigma NW) - .707(\Sigma SE + \Sigma NE)}{n} \quad (1)$$

$$R_y = \frac{\Sigma S - \Sigma W + 0.707(\Sigma SW + \Sigma SE) - 0.707(\Sigma NE + \Sigma NW)}{n} \quad (2)$$

where "n" in the denominator is the number of observations and the capitals stand for the speed of each directional component. Resultant speed determined by taking the square root of $Rx^2 + Ry^2$, and resultant direction from the tangent of Rx/Ry. Results from both deployment periods are plotted in Figure 3. Note that current data is in "direction to" and wind data "in direction from."

Resultant bottom current directions were dominantly to the north and south throughout, oscillations in direction occurring every 2–14 days (Figure 3a). Wind records showed a similar pattern with winds from both easterly and westerly quadrants dominating for periods ranging from 2–12 days (Figure 3b). There appeared to be some association between the wind and current directions, the strongest found between winds blowing from the east or northeast and a current flowing to the north.

Resultant current speeds oscillated considerably, ranging from a minimum of 0.05 ms^{-1} to a maximum of 0.32 ms^{-1} (Figure 3c), and reaching a maximum hourly observation of 0.44 ms^{-1} on 26-Jun-85. Three major high magnitude current events are apparent in the records, on the 26-Jun-85, 22-Jul-85, and 15–20-Sep-85. These high speed current events all coincide with periods of northerly flowing currents. Data obtained from both current meters show anomalously low speeds after a period of 45–60 days. This is most likely due to encrusting organisms building up and impeding movements of the savonious rotor on the current meter (HEALY *et al.*, 1987).

Oscillations in resultant wind speed ranged from 0.4–14.9 ms^{-1} and coincided with the current speed oscillations (Figure 3c). The unreliable nature of current speed data after 45–60 days is quite evident when compared with wind speed records in Figure 3c. High speed wind events were associated with resultant easterly and northeasterly wind directions. Therefore, the resultant current and wind data confirms the sea-bed drifter observation of high speed easterly winds associated with a strong shore-parallel inner shelf current flowing to the north.

Temperature and salinity records obtained from the current meters is shown in Figure 3d. Although the temperature data appeared accurate throughout both deployment periods, the salinity records seem inaccurate at the change over of current meters as shown by a measured 3‰ increase in salinity, this being most likely due to bio-fouling of the conductivity sensors on the current meter (BELL *et al.*, 1988). An important observation from the temperature and salinity records was the tendency for both to decrease sharply when the high speed northerly currents were present. This is probably due to large outflows of fluvial waters onto the inner

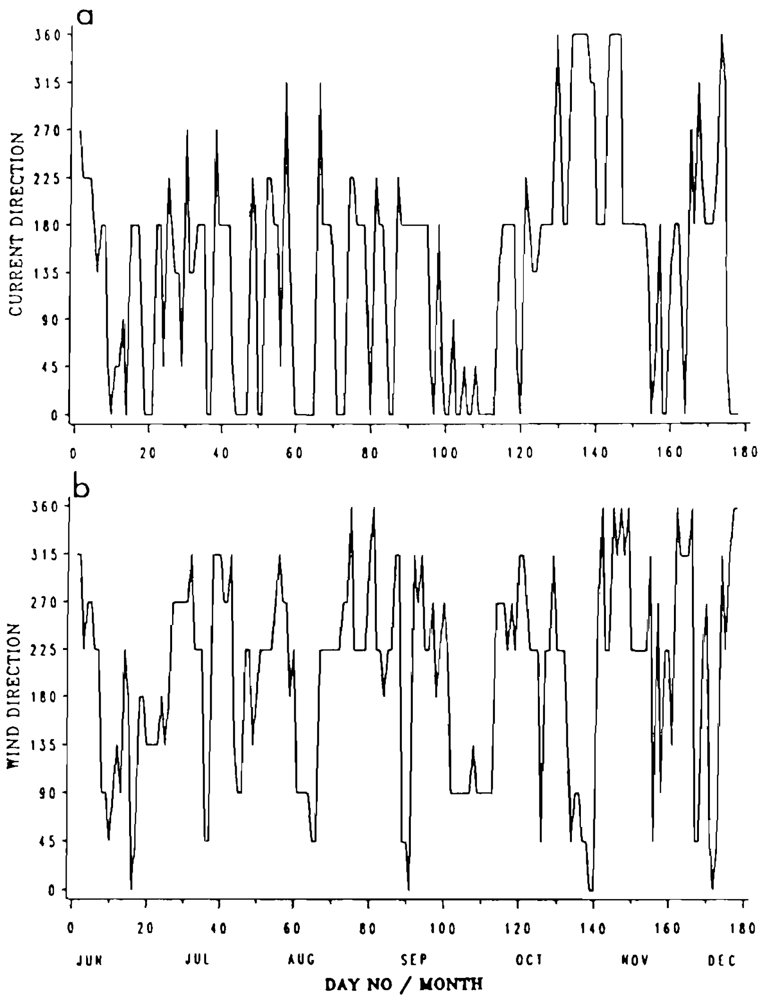

Figure 3. Time series plots of current and wind data from the east Coromandel study: (a) resultant current direction; (b) resultant wind direction.

shelf from Whangamata Harbour as a result of heavy rains associated with the easterly winds.

Current Flow Patterns During Storm Events

The resultant current and wind plots show some relationship exists between these during high magnitude wind speed events. To further examine the extent to which winds may be generating the near bottom inner shelf currents, hourly current and wind records were examined during storm events. Major events observed during portions of applicable wind and current records are shown in Figure 4. Note that the major current event on the 26-Jun-85 could not be examined as only Tauranga wind records were available in June 1985, which have been shown by DELL (1983) to have a good directional but poor speed correlation with the study area.

In the first event between the 11–14-Jul-85 (Figure 4a), a southeasterly tracking low pressure system migrated over the North Island and produced northeasterly winds exceeding 7 ms^{-1} for 30 hours and 12 ms^{-1} for 5 hours. An observable response in the current meter records occurred 20 hours later when speed increased

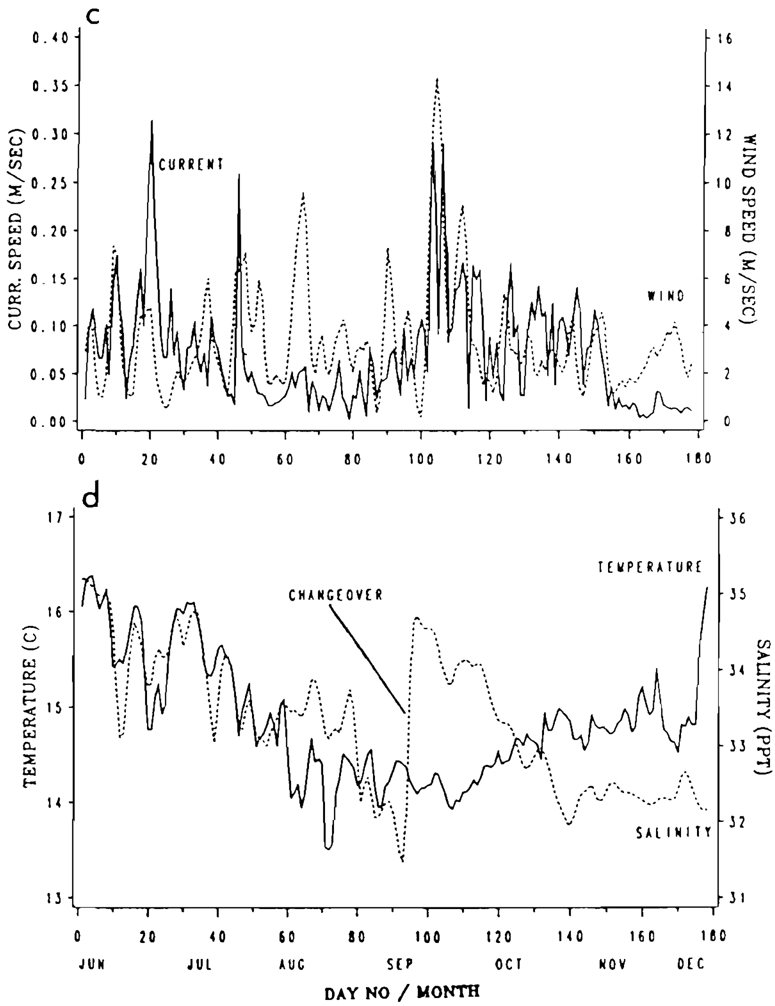

Figure 3. Cont. (c) resultant current and wind speed; and (d) mean water temperature and salinity (note apparent increase in salinity at change over of current meters).

by 0.05 ms^{-1} to a maximum of 0.18 ms^{-1}. Current direction at this time oscillated considerably from north to south, indicating that the winds were not strong enough to overwhelm the antecedent current conditions and cause a steady flow to the north. Six days later, a depression formed in the Tasman Sea and subsequently passed over New Zealand producing winds from the east-southeast in excess of 7 ms^{-1} for 30 hours and 12 ms^{-1} for 10 hours. A steady high speed current to the north of up to 0.39 ms^{-1} in speed was indicated in the current meter records within 10 hours, and remained high for about 30 hours. Wind direction remained constant for 40 hours, however the northerly current remained steady for 72 hours. It therefore appears that the time scale of current motion exceeded the inertial wind period.

Although no wave data was available during the current meter experiment, the significance of wave pumping affecting the current records was assessed through applying linear wave theory. For the above wind conditions, a significant wave height of 2.04 m and period of 6.5 seconds is predicted, which would produce a horizontal wave orbital velocity of 0.15 ms^{-1}. This is sig-

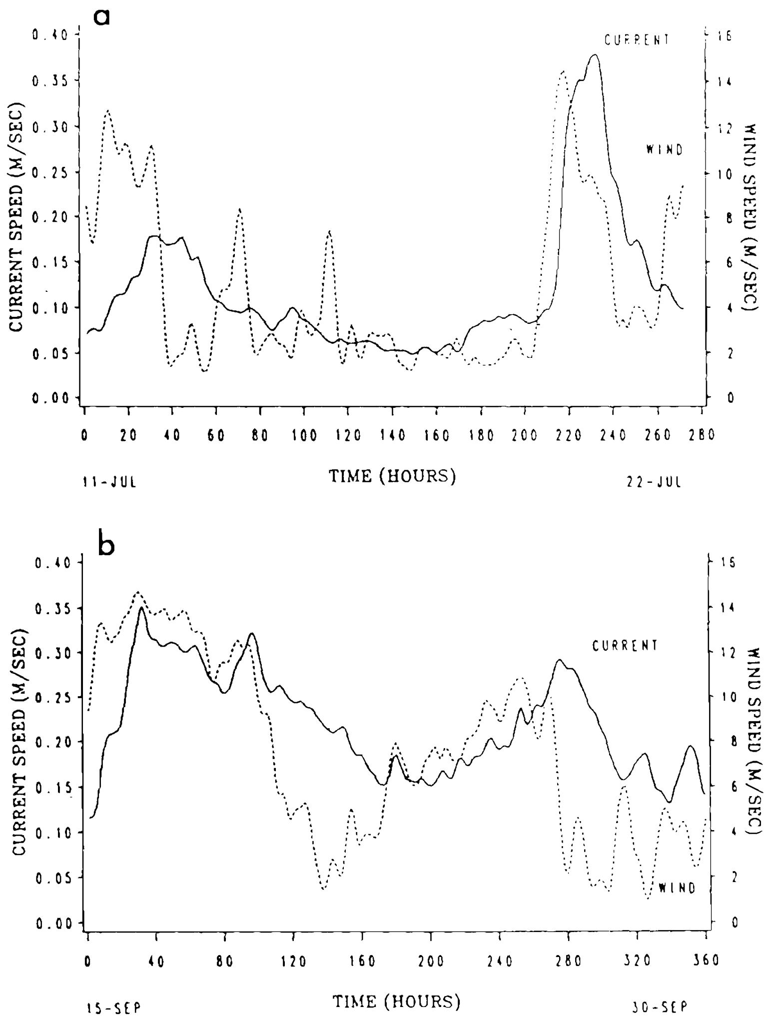

Figure 4. Hourly current and wind speed plots during major storm events: (a) 11-22-Jul-85; (b) 15–30-Sep-85.

nificantly less than that observed on the current records, and so it is assumed the effects of wave pumping were minimal.

Between the 15–29-Sep-85, a depression and associated cold front formed in the Tasman Sea, which upon migrating east became blocked over New Zealand by a stationary anticyclone to the east. Gale force easterly winds developed which exceeded 7 ms^{-1} for 110 hours and 12 ms^{-1} for 65 hours (Figure 4b). A steady northerly current up to 0.35 ms^{-1} in speed was generated within 5 hours and persisted for about 100 hours. Wind speed then dropped and changed direction, oscillating from both the southeast and east. Current speed also decreased, however the steady northerly current persisted. Wind speed increased again on 23-Sep-85 when another depression became blocked by the same stationary anticyclone off the east coast, and remained above 7 ms^{-1} for 80 hours. The steady northerly current responded about 30 hours later by increasing in speed to a maximum of 0.31 ms^{-1}. Again, it appears that the duration of the northerly current exceeded the inertial wind period.

Applying linear wave theory again to the second storm event, a significant wave height of 8.27 m and period of 14.3 seconds is predicted to have occurred. This would produce a horizontal wave orbital velocity of 3.24 ms^{-1} at the current meter mooring. As the highest speed registered on the current meter records was 0.36 ms^{-1}, the affects of wave pumping again appear to have been minimal.

The above results give some generalizations of the wind conditions necessary to generate inner shelf currents in the study area. Onshore directed winds exceeding 7 ms^{-1} cause an increase in current speed, but for a steady current (i.e. one of constant direction) to form, winds in excess of 12 ms^{-1} are required for at least 5 hours duration. However, antecedent current conditions are also important, as shown on the 23-Sep-85 where a steady high speed current persisted under low wind speed conditions due to presence of strong winds 3 days before. As reported by NIEDORODA *et al.* (1985), "specific response times are required for the current to adjust to changes in the local winds, weak or rapidly changing forces result in incoherent current patterns where as strongly forced flows of significant duration produce more coherent current patterns."

Forcing Mechanisms of Current Flows

Further information on the forcing mechanisms of inner shelf currents at Onemana was obtained by undertaking spectral analysis of the current and wind data. For this the "SAS SPECTRA" program was used. As any wind-driven currents present should be represented as low frequency (> 24 hours) oscillations, the filtered resultant current and wind data was again used for this analysis.

Portions of the raw aanderaa record indicating very low current speeds at the end of the deployment periods which did not correlate with the wind records were considered suspect and thus omitted from this analysis. The current data was separated into north and south components using the convention that the northerly component equaled the current if it was flowing to the north and zero if it were to the south, and likewise for the southerly component. The east-west wind data was broken down into an east and west component in a similar manner. This was done to allow the two current directions to have different causes.

Spectral density plots in Figures 5a and 5b show most of the energy of the longshore currents and cross-shore wind occur at low frequencies with broad peaks at periods of about 10 and 15 days duration.

Coherency squared plots between current and wind data are shown in Figure 5c. For the number of observations used in this analysis, published data in KOOPMANS (1974) shows the critical value for the test of the hypothesis $\rho = 0$ vs. $\rho \neq 0$ is 0.44. Coherency squared values above this critical value are judged to be statistically different from zero, whereas values below are statistically indistinguishable from zero in this study. This does not mean they are equal to zero, but rather that they are small compared to the variability in the data. Thus a strong linear association exists between currents to the north and winds from the east (60%) at frequencies equivalent to 15 and 3 days duration, but a much weaker association exists between the southerly directed current and offshore winds (<40%) over all frequencies.

Phase plots in Figure 5d show the average lead of winds over the currents at each frequency of the currents. The northerly current and easterly winds appear to be in phase at all but the highest frequencies, where the currents then tend to lag behind the winds. The southerly current and westerly winds in contrast are out of phase at relatively lower frequencies, the current continually lagging behind the wind.

Spectral density, explained spectral density (coherency squared times spectral density) and unexplained spectral density (one minus coherency squared times spectral density) are illustrated for both current patterns in Figures 5e and 5f. Figure 5e shows that most of the power of the northerly current can be explained by a linear relationship with the easterly wind. Figure 5f, however, shows that most of the power of the southerly current cannot be explained by a linear relationship with the westerly wind.

Results of the spectral analysis suggest that both of the major inner shelf bottom currents on the east Coromandel coast oscillate in direction and speed about every 10 or 15 days. They also indicate a possible wind-generated origin for the northerly currents by the local easterly winds. This is shown by the high proportion of spectral density over the frequency range that contains most of the power that can be explained by a linear regression on the easterly winds. The phase plot over this range shows that a line with a very small negative slope

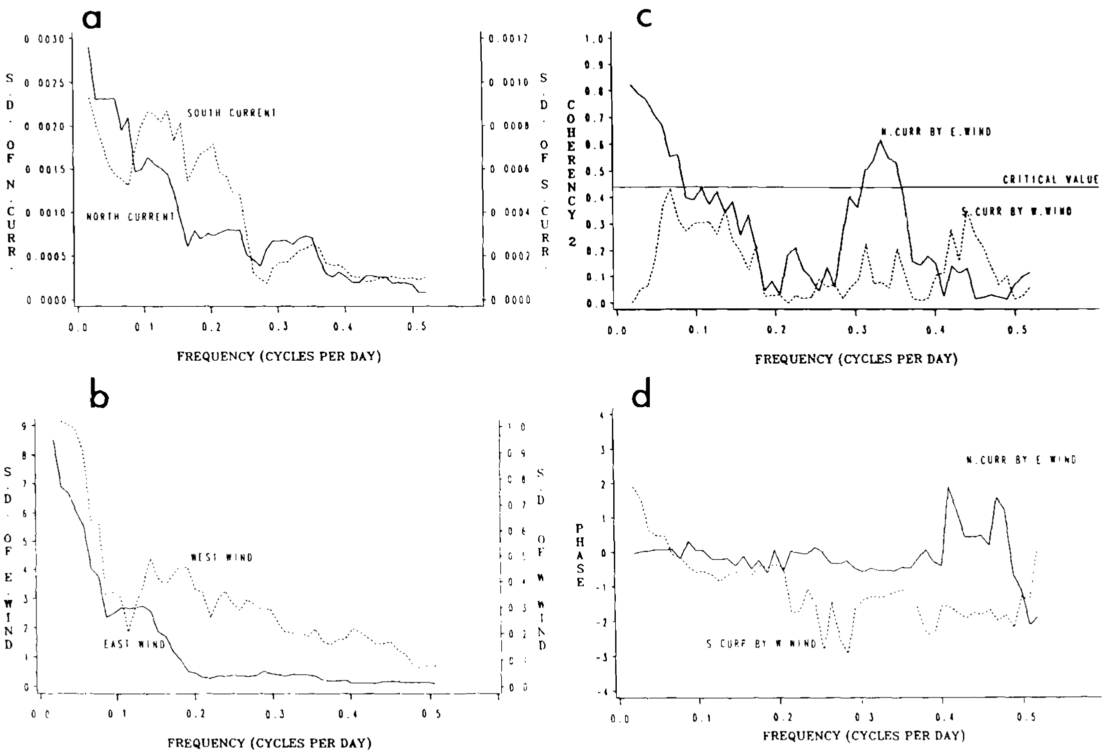

Figure 5. Spectral analysis plots of current and wind data: (a) spectral density of north and south currents; (b) spectral density of east and west winds; (c) coherency squared plots of north current by east winds and south current by west winds showing, critical value for hypothesis $\rho = 0$ vs. $\rho \neq 0$; (d) phase plots of north current by east wind and south current by west wind in units π.

would give a good fit. This indicates that there is only a slight delay in the onset of the current following the occurrence of the easterly winds. However, the results seem to indicate a remotely forced origin for the southerly current. This is shown by the low proportion of spectral density over the frequency range containing most of the power that can be explained by a linear regression on the westerly winds.

Mean Circulation and Potential Net Sediment Transport

To determine the mean inner shelf current circulation and directions of potential net sediment transport, the frequency of each current direction at three speed ranges was determined. A suitable sediment transport threshold value for the action of currents only was first calculated by using the method outlined by BLACK (1983) which accounts for the surface roughness of the sea-bed.

The method involves firstly calculating the critical skin friction velocity ($\bar{u}_{*cr}$) from the Yalin threshold curve. For fine sand this corresponds to a value of $\bar{u}_{*cr} = 0.0128 \text{ ms}^{-1}$.

Surface roughness (z_o) over 2-dimensional bedforms is calculated by

$$z_o = \frac{\Delta^2}{2\Delta} \tag{3}$$

where Δ = height and Δ = wavelength. For the Onemana shelf where the current meter was moored, rippled bedforms were observed of height 0.03 m and wavelength 0.13 m giving a z_o value of 0.0035.

The critical form drag friction factor c″ is then determined from

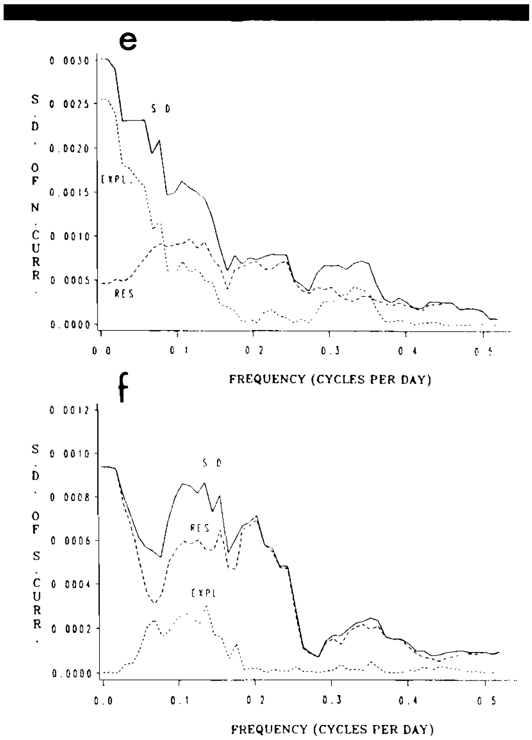

Figure 5. Cont. Spectral density (S.D.), explained spectral density (EXPL.) and unexplained spectral density (RES.). Plots for (e) north and (f) south currents.

$$\frac{c''}{\sqrt{8}} = 3.3 \log_{10} \left(\frac{D}{2z_o}\right) - 2.3 \qquad (4)$$

where D = water depth (26 m) giving a value of $c'' = 26.8$.

Critical friction velocity $\bar{u}_{*cr}$ is given by

$$u_{*cr} = \frac{u_{*cr}}{\left(1 - \left[\frac{5.75}{c''} \log_{10} \left(\frac{0.37D}{z_o}\right)\right]^2\right)^{1/2}} \qquad (5)$$

$= 0.019\ ms^{-1}$

and related to critical threshold velocity at 1 m above the sea floor(u_{1cr})

$$u_{1cr} = 5.75\ u_{*cr} \log_{10} \left(\frac{1}{z_o}\right) \qquad (6)$$

$= 0.26\ ms^{-1}$

However, this method does not account for the important effect wave oscillatory currents will have on the threshold speed for sediment movement. VINCENT *et al.* (1981) deduced that large waves during storm events cause much lower than the current threshold speed to be exceeded for a fraction of each wave period at suitable water depths. Following on from the results of GADD *et al.* (1978) from Long Island in North America, they used a range of threshold values between 0.15–0.20 ms^{-1}. From the previously mentioned predicted wave data during the major storm events, it is obvious that wave oscillatory currents interact with the sea floor, thus warranting use of a second threshold value estimated as 0.18 ms^{-1}.

Frequencies for each velocity range are plotted as current rose diagrams in Figures 6a and 6b. Care was taken to include only data from the accurate portions of the current meter records. During the first deployment period (Figure 6a), the most frequent current directions were to the south (24.2%), southwest (17.6%), north (16%), southeast (15.1%) and northeast (10.6%). Threshold speeds were exceeded 24.3% for the 0.18 ms^{-1} value and 13.5% for the 0.26 ms^{-1} value in all directions. However, the most significant directions for exceedence were to the north (7.4%, 5.2%) and northeast (4.8%, 2.5%).

Results from the second deployment period (Figure 6b) showed two current directions dominating throughout, to the south (32.6%) and north (28.8%). In comparison, other current directions were relatively insignificant. Currents exceeding threshold speeds occurred 18.7% and 8.6% for the 0.18 ms^{-1} and 0.26 ms^{-1} values respectively. Again, the most significant directions were to the north (7.4%, 3.6%) and northeast (4.2%, 2.2%).

Aanderaa current records from both deployment periods were further analyzed through the University of Waikato's computer progressive vector analysis program, "RESIDUAL," using the same current threshold speeds. Plots are shown in Figures 7a–e. During the first deployment period, the overall residual current direction was to the southeast (Figure 7a), however the residual direction for currents greater than both threshold speeds (Figures 7b and 7c) were overwhelmingly to the north. Results from the second deployment period show an overall northerly residual current direction (Figure 7d) and a northerly direction of potential inner shelf sediment transport again at both threshold values (Figure 7e and 7f).

It therefore appears that on the east Coromandel inner shelf, whilst the mean current

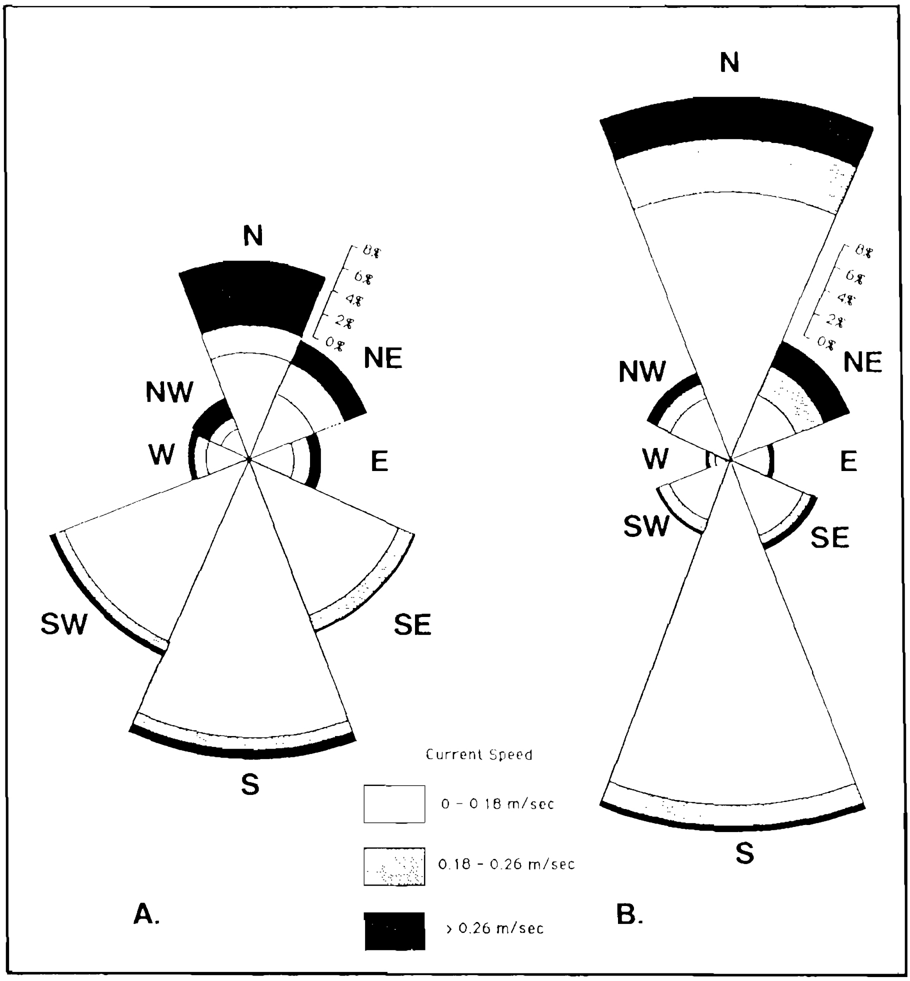

Figure 6. Current roses for both threshold speed values from hourly observations between: (a) 6-Jun-30-Jul-85; (b) 8-Sep-1-Nov-85.

flow may be directed to the south during calm weather periods, the direction of potential sediment transport will be directed north during episodic storm events, regardless of whether or not wave oscillatory currents interact with the steady current flows. Also, as noted on the Long Island coast by NIEDORODA *et al.* (1984), the same strong onshore winds that generate the steady northerly currents will also generate high waves, thus intensifying rates of sediment transport to the north during these storm events.

In order to determine some idea of the average annual frequency of sediment transport on the east Coromandel coast, the probability of exceedence of various wind speeds was calculated from the 18 months of wind records at Whiritoa, and is shown in Figure 8. Winds exceeding 7 ms^{-1} and capable of generating a current response were found to occur 6% of the time, however the winds exceeding 12 ms^{-1} and most likely to generate a steady current of sufficient speed to transport inner shelf sediments were found to occur only 0.5% of the time. These high magnitude wind events were all from the east or northeast, and most frequent between June and October (winter and spring).

As no published longer term wind records are

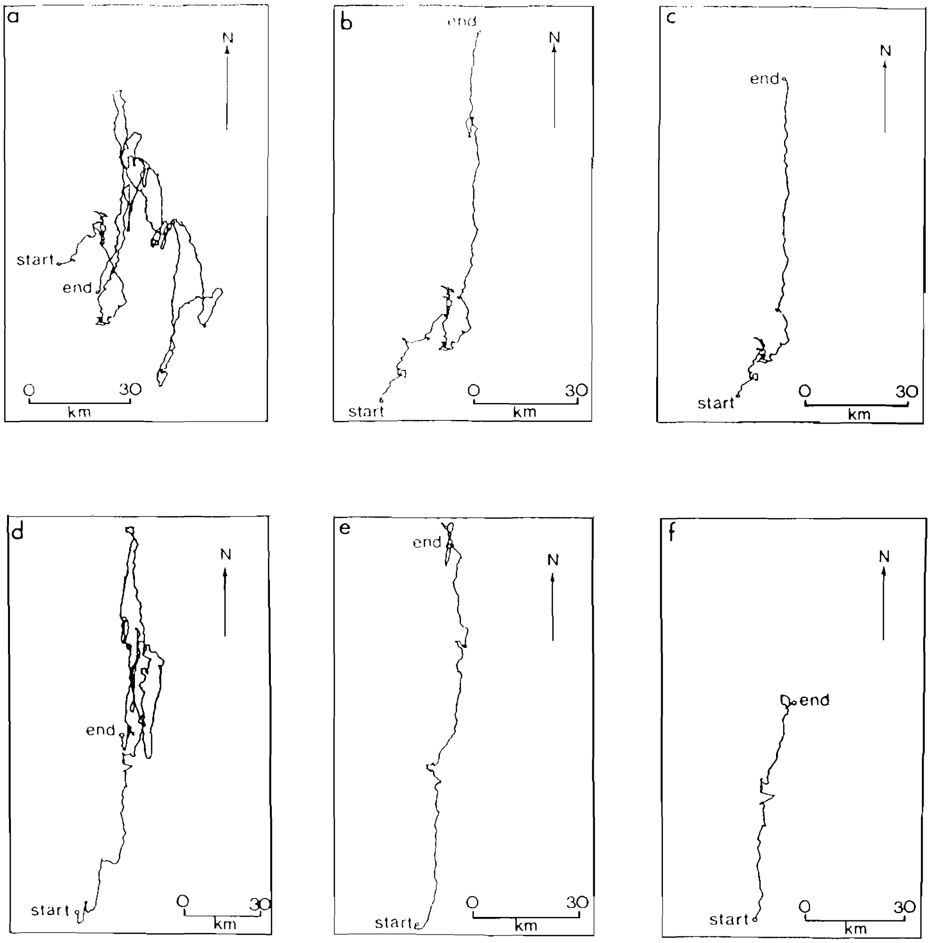

Figure 7. Progressive vector plots for threshold speed values of 0 ms^{-1}, 0.18 ms^{-1} and 0.26 ms^{-1} for the periods: 6-Jun–30-Jul-85 (a,b and c); and 8-Sep-1-Nov-85 (d,e and f).

available from the study area, it is difficult to determine the long term frequency of potential sediment transport. However, annual summaries of maximum wind run values obtained from the New Zealand Meteorological Service for the period 1969–1986, the maximum wind run observed in September 1985 of 518 km is only slightly below the average maximum value of 580 km. From this longer term data it also seems that high speed wind events occur most frequently in September and October each year. Therefore, conclusions drawn from the Whiritoa wind data appear to be fairly representative of mean conditions.

Model for East Coromandel Inner Shelf Flows

The east Coromandel regional inner shelf current pattern is dominated by two shore-parallel bottom currents which flow to the north and south. Conceptual models of current dynamics and sediment transport for each current pattern are illustrated in Figures 9a and 9b.

Frequent periods of calm weather conditions are characterized by the presence of a southerly flowing current (Figure 9a), which typically ranges in speed from 0.10–0.20 ms^{-1}. As the

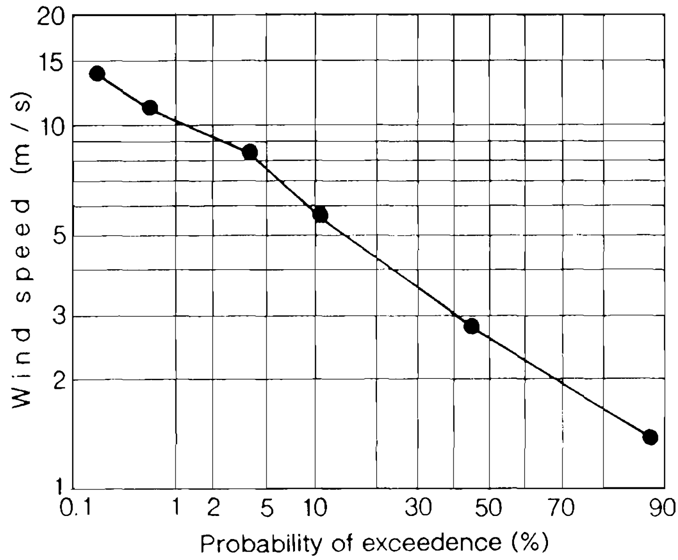

Figure 8. Probability of exceedence for various wind speeds from 18 months of wind records (3-Jul-85 to 26-Jan-87) obtained from Whiritoa.

current does not exceed threshold current speeds, and as significantly high waves would not be generated by the offshore winds to interact with the steady current, no long-shelf sediment transport should occur during these fair weather periods. From diver observations taken during such calm weather conditions, slight to and fro movement of sand by wave oscillatory currents was found at depths ranging from 24m to 12m, but sediment transport was only found at shallower depths where a net onshore movement of sand occurs.

Although the current tends to be associated with the presence of local offshore west and southwesterly winds, it does not appear to be directly generated by these. One possible origin for this flow is from the southward directed East Auckland Current. As the core of the East Auckland Current is located over the continental slope (DENHAM *et al.*, 1984), it is possible that the southerly flowing current is formed by waters from this penetrating the continental shelf.

Evidence supporting this hypothesis includes:

(1) similar water temperatures and salinities of the southerly flowing current with those reported for the East Auckland Current by BARKER and KIBBLEWHITE (1965);

(2) East Auckland Current velocities reported by HEATH (1980) of between 0.18–0.30 ms^{-1} are slightly greater than those observed for the southerly flowing current, as would be expected due to bottom friction over the continental slope and shelf;

(3) the absence of a southerly flowing current in one sea-bed drifter experiment conducted in summer, a period in which the East Auckland Current has been observed by DENHAM *et al.* (1984) to migrate further offshore; and

(4) similar observations in eastern Australia, where eddies from the East Australian Current, which ultimately feeds the East Auckland Current, frequently penetrate the continental shelf (GORDON and HOFFMAN, 1986).

The infrequent intrusion of cyclonic depressions from the Tasman Sea into the study area results in the presence of strong onshore winds and the formation of a northerly flowing bottom current, observed at speeds up to 0.40 ms^{-1} (Figure 9b). The current alone is capable of transporting inner shelf sediments, however the presence of storm-generated waves should act to intensify the rates of sediment movement to the north.

As this northerly current appears to be generated by local onshore winds, the most obvious interpretation for the flow is that it represents

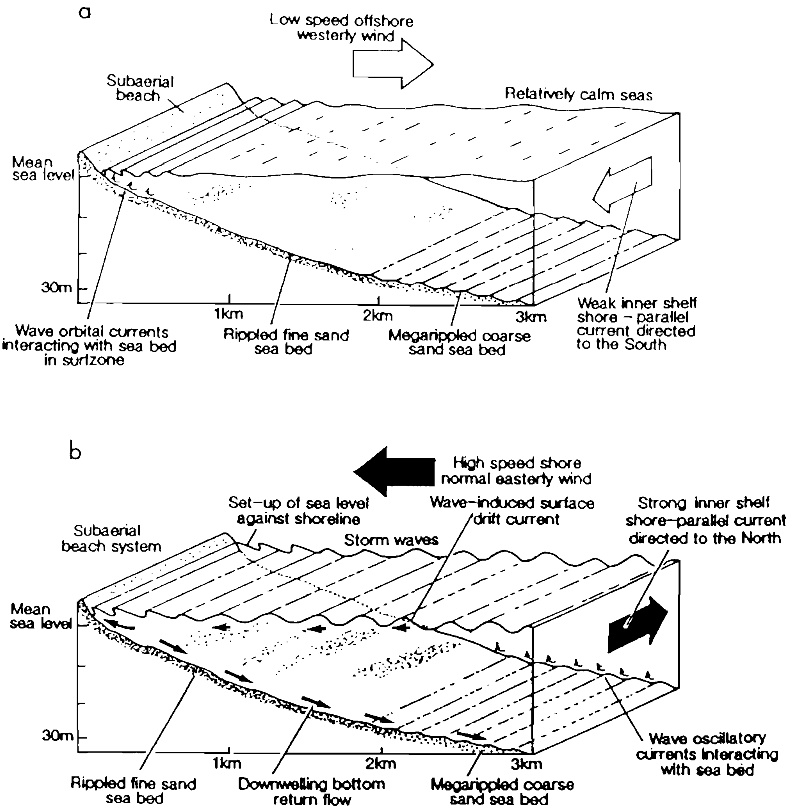

Figure 9. Conceptual models for inner shelf dynamics and sediment transport during: (a) calm weather periods characterized by a weak southerly flowing current and transport restricted to the surfzone; (b) episodic stormy periods dominated by downwelling conditions and a strong flowing current resulting in alongshelf sediment transport to the north.

part of a more complex 3-dimensional downwelling circulation as described in North America by NIEDORODA *et al.* (1985) and SNEDDEN *et al.* (1988), and in eastern Australia by FIELD and ROY (1984) and GORDON and HOFFMAN (1986). The interpretation is that onshore winds acting over a limited fetch, in combination with storm surge and inverse barometric effects, cause a set-up of water against the shore. A cross shelf pressure gradient would then develop causing a bottom return or downwelling flow. The shore-parallel northerly current maintains a geostrophic balance with pressure gradient and Coriolis forces, as indicated by the tendency for the duration of the current to exceed inertial wind periods.

High rainfalls produced by the Tasman Depressions cause sharp drops in water temperature and salinity, and may therefore produce density stratification and a baroclinic component to the northerly flow. However, turbulence during these storm events is probably quite high and may cause complete mixing of the water column.

Another factor that must be considered is the variable coastal topography in the study area. This along with a variable wind climate could lead to the generation of edge waves somewhere in the Bay of Plenty which could then propagate northwards along the east Coromandel coast. Edge waves have been previously identified along the east coast of New Zealand by HEATH (1979, 1982), however, their presence cannot be confirmed from the limited current data collected in this study.

From this model, it is concluded that alongshelf sediment transport is directed to the north along the east Coromandel coast between Waihi and Mercury Bay, and occurs during episodic storm events. However, where volcanic islands occur close to the shore, as described by DELL (1983) at Tairua, constriction of flows may occur resulting in high current speeds both north and south during calm and stormy periods.

CONCLUSIONS

An initial account of the east Coromandel inner shelf current patterns has been possible in this study through collecting detailed current measurements from one site (Onemana) and integrating this with the regional current patterns obtained from extensive sea-bed drifter experiments. From this approach, the study area was found to be dominated by two shore-parallel near bottom current flows.

Throughout much of the year, particularly in summer and autumn, calm weather periods prevail in the study area as mid-latitude anticyclones dominate the local weather patterns. Associated with these calm weather periods was found a relatively weak southerly flowing current, which was of insufficient speed to transport inner shelf sediments. Evidence presented in this study seems to indicate that this southerly flow is remotely forced, and possibly forms part of the regional East Auckland Current flow.

The episodic generation of low pressure systems in the Tasman Sea and their subsequent passage over the study area cause the local formation of strong onshore easterly winds. A northerly current was found to be generated by these onshore directed winds. An important observation from the study was that this wind-generated current would only develop a steady, coherent flow pattern if the winds were of sufficient speed and duration (>12 ms^{-1} speed and 5 hours duration), although antecedent current conditions were also important. This northerly current was measured at sufficient speeds to transport inner shelf sediments, with waves formed by the same onshore winds likely to intensify rates of sediment transport. As the weather patterns observed during the study seem representative of average conditions, it is possible that inner shelf sediments are being transported northwards along parts of the east Coromandel coast.

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LITERATURE CITED

BARTOLINI, C., and PRANZINI, E., 1977. Tracing nearshore bottom currents with sea-bed drifters. *Marine Geology,* 23, 275–284.

BARKER, P.H., and KIBBLEWHITE, A.C., 1965. Physical oceanographic data from the TUI cruise 1962. *New Zealand Journal of Science,* 8, 604–634.

BELL, R.G.; OLDMAN, J.W., and HUME, T.M., 1988. A handbook on the use of moored current meters in coastal waters. *Water and Soil Miscellaneous Publication No. 117,* Water Quality Center, Ministry of Works and Development, Hamilton, New Zealand,64p.

BLACK, K.P., 1983. Sediment Transport and Tidal Inlet Hydraulics. D. Phil. Thesis, University of Waikato, Hamilton, New Zealand. Vol. 1 (text, 159p) and Vol. 2 (figures).

BRODIE, J.W., 1960. Coastal surface currents around New Zealand. *New Zealand Journal of Geology and Geophysics,* 3, 235–252.

CARTER, L., and HEATH, R.A., 1975. Roles of mean circulation, tides, and waves in transport of bottom sediment on the New Zealand continental shelf. *New Zealand Journal of Marine and Freshwater Research,* 9, 423–448.

CHRISTOPHERSEN, M.J., 1977. Beach Erosion at Whiritoa Beach. M.Sc. Thesis, University of Waikato, Hamilton, New Zealand, 120p.

DAVIS, R.A., Jr., and HAYES, M.O., 1984. What is a wave dominated coast? *Marine Geology,* 60, 313–329.

DELL, P.M., 1983. *The offshore and nearshore current circulation patterns at Pauanui and Tairua.* Hauraki Catchment Board, Te Aroha, New Zealand, Report No. 142, 30p.

DELL, P.M.; HEALY, T.R., and NELSON, C.S., 1985. A preliminary investigation of the sediments on the eastern Coromandel inner shelf and implications for across-shelf sediment transport. *Australasian Conference on Coastal and Ocean Engineering,* 489–499.

DENHAM, R.N.; BANNISTER, R.W.; GUTHRIE, K.M., and CROOK, F.G., 1984. Surveys of the East Auckland and East Cape Currents, New Zealand. *Australian Journal of Marine and Freshwater Research,* 3491–3504.

FIELD, M.E., and ROY, P.S., 1984. Offshore transport and sand-body formation: evidence from a steep high-energy shoreface, southeastern Australia. *Journal of Sedimentary Petrology,* 54, 1292–1302.

GADD, P.E.; LAVELLE, J.W., and SWIFT, D.J.P., 1978. Estimates of sand transport on the New York shelf using near-bottom current meter observations. *Journal of Sedimentary Petrology*, 48, 239–252.

GORDON, A.D., and HOFFMAN, J.G., 1986. Sediment features and processes of the Sydney continental shelf. *In*: E. Frankel, J.B. Keene, and A.E. Waltho (eds.), *Recent sediments in Eastern Australia—Marine Through Terrestrial*. Publication of the Geological Society of Australia, N.S.W. Division No. 2, pp. 29–51.

GREGORY, M.R., 1979. Movement of sea-bed drifters near Oaonui. *University of Auckland, Maui Development Environmental Study Phase II*, Report No. 79-21, 10p.

HAMMOND, R.R., and WALLACE, W.J., 1982. Seabed drifter movements in the San Diego Bay and adjacent waters. *Estuarine Coastal and Shelf Science*, 14, 623–634.

HARRAY, K., and HEALY, T.R., 1978. Beach erosion at Waihi Beach, Bay of Plenty, New Zealand, *New Zealand Journal of Marine and Freshwater Research*, 12, 99–107.

HARRIS, T.F.W.; HUGHES, T.S., and VALENTINE, E.M., 1983. Deep waves off Hicks Bay and the northeast coast, North Island. *Water and Soil Miscellaneous Publication*, No. 56, 83p.

HEALY, T.R., 1981. Impact of proposed sand mining on an isolated unspoiled beach system—the case of Mataora, east Coromandel, N.Z. *Proceedings of the 11th New Zealand Geography Conference*, pp. 167–172.

HEALY, T.R.; DELL, P.M., and WILLOUGHBY, A.J., 1981. *Coromandel Coastal Survey Volume 1, Basic Survey Data*. Hauraki Catchment Board, Te Aroha, New Zealand, Report No. 114, 233p.

HEALY, T.R., and DELL, P.M., 1982. *The Coromandel Coastal Survey Volume 2, Beach Sediment Textural and Mineralogical Data*. Hauraki Catchment Board, Te Aroha, New Zealand, Report No. 115, 31p.

HEALY, T.R., and DELL, P.M., 1987. Baseline data beach surveys for management of an embayed coastline, east Coromandel, New Zealand. *Journal of Shoreline Management*, 3, 129–157.

HEALY, T.R.; BLACK, K.P., and DeLANGE, W.P., 1987. Field investigations required for numerical modelling studies of port developments in large tidal inlet harbours. *International Geomorphology*, 1, 1099–1112.

HEATH, R.A., 1978. Atmospherically induced water motions off the west coast of New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 12, 381–390.

HEATH, R.A., 1979. Edge waves on the New Zealand east coast. *Marine Geodesy*, 4, 337–350.

HEATH, R.A., 1980. East oceanic flow past northern New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 14, 169–182.

HEATH, R.A., 1982. Generation of 2–3 hour oscillations on the east coast of New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 16, 111–117.

HEATH, R.A., 1985. Large scale influence of the New Zealand seafloor topography on western boundary currents of the South Pacific Ocean. *Australian Journal of Marine and Freshwater Research*, 36, 1–14.

INMAN, D.L., and NORDSTROM, C.E., 1971. On the tectonic and morphologic classification of coasts. *Journal of Geology*, 79, 1–21.

KIBBLEWHITE, A.C.; BERGQUIST, P.R.; FOSTER, B.A., and GREGORY, M.R., 1982. *Maui Development Environmental Study, Report on Phase 2*. Report prepared at the University of Auckland, New Zealand, for Shell B.P. and Todd Oil Services Limited, 174p.

KOOPMANS, L.H., 1974. *Spectral analysis of time series*. New York: Academic Press, 366p.

McLEAN, R.F., 1979. Dimensions of the Whiritoa Sand System and Implications for Sand Mining and Shore Erosion. Unpublished Report to the Hauraki Catchment Board, Te Aroha, New Zealand.

MARSDEN, M.A.H., 1979. Circulation patterns from sea-bed drifter studies, Western Port and inner Bass Strait, Australia. *Marine Geology*, 30, 85–99.

NIEDORODA, A.W.; SWIFT, D.J.; HOPKINS, T.S., and CHEN-MEAN, M.A., 1984. Shoreface morphodynamics on wave-dominated coasts. *Marine Geology*, 60, 331–354.

NIEDORODA, A.W.; SWIFT, D.J., and HOPKINS, T.S., 1985. The shoreface. *In:* R.A. Davis, (ed.), *Coastal Sedimentary Environments*. New York: Springer-Verlag, pp. 533–624.

PANOFSKY, and BRIER, 1968. *Some Applications of Statistics to Meteorology*. Pennsylvania State University Publication, 224p.

PEEK, S.M., 1979. A Comparative Study of Beach Morphodynamics on the East and West Coasts of the North Island, New Zealand. M.A. Thesis, University of Auckland, Auckland, New Zealand, 112p.

PHILLIPS, A.W., 1970. The use of the Woodhead seabed drifter. *British Geomorphological Research Group, Technical Bulletin*, 4, 29p.

SAS/ETS, 1984. *User's Guide, Version 5 Edition*. Cary, NC: SAS Institute Inc., 738p.

SKINNER, D.N.B., 1976. Sheet N40 and parts N35, N36, N39 Northern Coromandel (1st ed.). *Geological map of New Zealand 1:63 360*, Department of Scientific and Industrial Research, Wellington, New Zealand.

SMITH, D.B., 1980. Sea Level Oscillations, Hydrology and Sedimentology of Mercury Bay. M.Sc. Thesis, University of Waikato, Hamilton, New Zealand, 235p.

SNEDDEN, J.W.; NUMMEDAL, D., and AMOS, A.F., 1988. Storm and fair-weather combined flow on the central Texas continental shelf. *Journal of Sedimentary Petrology*, 58, 580–595.

STANTON, B., 1981. An oceanographic survey of the Tasman Front. *New Zealand Journal of Marine and Freshwater Research*, 15, 289–297.

VINCENT, C.E.; SWIFT, D.J.P., and HILLARD, B., 1981. Sediment transport in the New York Bight, North American Atlantic shelf. *Marine Geology*, 42, 369–398.

WILLOUGHBY, A.J., 1981. Nearshore Sediments of Whiritoa Beach, Coromandel Peninsula, New Zealand. M.Sc. Thesis, University of Waikato, Hamilton, New Zealand, 123p.

WOODHEAD, P.M.J., and LEE, A.J., 1960. A new instrument for measuring residual currents near the seabed. *International Council for Exploration of the Sea C.M. 1960 Hydrographic Committee*, No. 12, 6p.

□ RESUMEN □

Se ha analizado las primeras observaciones de la oceanografía costera en la plataforma interior del Este de Coromandel utilizando los resultados combinados de experimentos de arrastre por fondo y de registros continuos de velocidad de corriente mediante instrumentos Aaranderaa. La plataforma interior en esta zona es bastante estrecha, oscilando entre los 20 y 30 km para la batimétrica-200 m. Las corrientes cercanas al fondo en la zona de estudio se caracterizan por dos flujos paralelos a la costa. Durante las temporadas de calma atmosférica, fluye hacia el Sur una corriente relativamente suave, con velocidades entre los 0.10 y los 0.20 cm/s. Esta corriente parece ser una corriente de fondo forzada, asociada posiblemente por la Corriente del Este de Auckland, que se dirige hadcia el Sur. Los sucesos episódicos de temporal, asociados con las depresiones ciclónicas, generan fuertes corrientes en dirección al Norte con velocidades medidas de hasta 0.4 m/s. Esta es una corriente de fondo generada localmente por el viento y probablemente representa una parte de un sistema tridimensional de circulación más complejo asociado a condiciones de hundimiento del agua superficial. Considerando el efecto combinado de las corrientes y de la dinámica del oleaje se ha encontrado que las trayectorias potenciales del transporte de sedimentos sobre la plataforma se dirigen hacia el Norte durante los períodos tempestuosos. Estos sucesos de vientos de alta magnitud se concentran durante el invierno y la primavera cada año y se produjeron con poca frecuencia (0.5%–6% en promedio) durante el estudio.—*Department of Water Sciences, University of Cantabria, Santander, Spain.*

□ RÉSUMÉ □

Les premières observations effectuées sur la côte Est de Coromandel, au Nord de la Nouvelle Zélande, combinent des expérimentations de mesure de vitesse sur le fond et des enregistrements continus au courantomètre Aanderaa. A cet endroit, le plateau continental est assez étroit: 20 à 30 km jusqu'à la courbe bathymétrique de 200 m. Les courants du fond sont caractérisés par deux écoulements parallèles à la côte. Par temps calme, un faible écoulement vers le Sud, avec des vitesses de 0.1–0.2 m/s, semble résulter d'un courant de fond forcé à distance, peut être associé au courant d'East Auckland, dirigé vers le Sud. Des épisodes de tempête associés aux dépressions cycloniques engendrent un fort courant dirigé vers le Nord, dont la vitesse est supérieure à 0.4 m/s. C'est un courant de fond, engendré localement par le vent, et qui s'intègre à une circulation tridimentionnelle bien plus complexe associant des mouvements de descente de l'eau. Si l'on considère les courants et leur dynamique combinée à celle de la houle, on constate que, pendant les épisodes de tempête, il s'effectue un transport sédimentaire vers le Nord. Des évènements d'une telle ampleur ont lieu en hiver et au printemps et sont exceptionnels (0.5 à 6% du temps de l'étude).—*Catherine Bressolier-Bousquet, Laboratoire de Géomorphologie EPHE, Montrouge, France.*

□ ZUSAMMENFASSUNG □

Erste Beobachtungen über die Küstenozeanographie des östlichen Teils des inneren Coromandel-Schelfs, NE Neuseeland, wurden überprüft. Dazu wurden die Resultate von Experimenten zur Drift am Meeresboden und die Daten selbstschreibender Aanderaa-Strömungsmesser verwandt. An dieser Lokalität ist der innere Schelf relativ schmal: er erreicht 20-30 km bis zur 200 m-Isobathe. Im Untersuchungsgebiet sind die bodennahen Strömungen durch zwei küstenparallele Fließrichtungen gekennzeichnet. Bei ruhigem Wetter fließt eine relativ schwache Strömung mit Geschwindigkeiten zwischen 0.10–0.20 m/sec südwärts. Dies scheint eine ferngesteuerte Bodenströmung zu sein, die möglicherweise mit dem südwärts gerichteten Ost-Auckland-Strom zusammenhängt. Episodische, mit zyklonalen Tiefs auftretende Sturmereignisse bewirken eine starke nordwärtige Strömung, bei der Geschwindigkeiten bis 0.40 m/sec gemessen wurden. Dies ist ein lokaler, durch Winde gesteuerter Bodenwasserstrom, der wahrscheinlich den Teil einer komplexeren, dreidimensionalen Zirkulation darstellt, die mit Abwallungsbedingungen zusammenhängt. Unter Beachtung der durch Strömungen und die Kombination von Wellen und Strömungen bewirkten Dynamik wurde herausgefunden, daß die möglichen Sedimenttransportbahnen auf dem Schelf während episodischer Sturmereignisse nordwärts gerichtet sind. Solche Sturmereignisse konzentrieren sich jedes Jahr auf den Winter und das Frühjahr; sie traten während dieser Untersuchung relativ selten (0.5%–6% pro Jahr) auf.—*Helmut Brückner, Geographisches Institut, Universität Düsseldorf, F.R.G.*