Report of R.R.S. Discovery 202
BEST: CTD Component

[Cape Town to Cape Town, 7 May to 3 June 1993]

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Contents:

I Introduction:

[A] Oceanographic Setting:

Wind-driven ocean circulation models as well as field observations reveal significant transfer of Indian Ocean Central (thermocline) Water into the South Atlantic Ocean. The transfer is accomplished by an eddy shedding process at the western end of the Agulhas Retroflection and by intermittent streams or plumes of Indian Ocean water injected into the Benguela Current of the South Atlantic. Their heat and salt content and rotational energy influence the state of the Atlantic Ocean. Perhaps the most profound effect is that the Atlantic's salinity is increased by drawing salty water from the evaporative Indian Ocean. A saltier Atlantic may be linked with increased formation of North Atlantic Deep Water and the associated vigor of the climatic important global thermohaline circulation.

[B] Research Questions and the **BEST** Project:

° What is the source and transport of the Benguela Current and how do they vary with time?
° What is the dominant means of transfer of Agulhas water into the Atlantic?
° What is the interaction of the Agulhas eddy field and the larger scale circulation field?

The **BEST** (Benguela Source and Transport) project is designed to pursue these questions, to investigate the form of the Benguela Current and ratio of the Agulhas Current and South Atlantic Current source waters masses. The transport and its variability is measured by a moored array of instruments as well as analysis of the TOPEX/POSEIDON satellite altimeter. The source of the water is determined by analysis of the water mass properties measured from ship. **BEST** mooring array was deployed in June 1992 (from the South African vessel, Africana) and will be recovered in October 1993 (from the US research vessel, M. Ewing). The moorings consist of PIES (bottom moored pressure and invert echo sounder instruments) & current meter strings along 30°S and IES along a diagonal from 37.5°, 12.3°E to Cape Town (Fig. 1 shows the distribution of the **BEST** moorings).

[C] Objectives of R.R.S. Discovery Cruise 202:

R.R.S. Discovery cruise 202 is the primary CTD component of the **BEST** project. The two basic objectives of cruise 202 are to:

° Obtain CTD stations over the **BEST** moorings. These CTD stations provide a "snap-shot" view of the thermohaline and oxygen stratification to help interpret the moored array time series by exhibiting how specific features are manifested in the PIES and current meter records; and

° Survey Agulhas eddies and their surrounding waters as to better define the distribution of Indian Ocean (Agulhas Current and Retroflection) and South Atlantic (South Atlantic Current) water within the Benguela Current.

II Personnel:

The scientific team joining the R.R.S. Discovery for cruise 202 consisted of 9 people from the Lamont-Doherty Earth Observatory of Columbia University, located in Palisades, New York, USA and two people from Sea Fisheries of the Republic of South Africa (RSA).

Table 1a Lamont-Doherty Earth Observatory and Sea

Fisheries Personnel Research aboard R.R.S. Discovery Cruise 202

Arnold L. Gordon	Principal Science Officer
Bruce Huber	Senior Research Associate
Philip Mele	Research Associate
Marcela Stern	Electronic Technician
Steward Sutherland	Staff Scientist
Anthony Martino	Research Assistant
Deirdre Byrne	Graduate Student [Columbia]
Paul Marchese	Graduate Student [Columbia]
Steve Rock	Graduate Student [Columbia]
Chris Duncombe-Rea	Graduate Student [Seas Fisheries & U.Cape Town]
Christine Illert	Technician [Seas Fisheries]

There were five technicians from NERC/RVS:

Andrew N. Cormack	Computer Tech
Jeff L. Jones	Mechanic Tech
Richard A. Phipps	Mechanic Tech
Chris Rymer	Mechanic Tech
"Bernie" C. W. Woodley	Electronics Tech.

<u>III Data Collection</u>:

[A] Introduction:

1- <u>Station work</u>: Water column thermohaline stratification (water masses) were measured with the LDEO's CTD units. Water samples were obtained with a twenty four bottle, 1.7 liter Rosette system. Water samples are obtained from the rosette system for: salinity required for CTD calibration; oxygen (for precise oxygen data and calibration of the Neil Brown oxygen probe); nutrient samples, which were frozen to be run ashore at the Sea Fisheries in Cape Town; alkalinity and pH, a carbon budget related program of Geoff Bailey at the University of Cape Town. Surface water plankton samples were collected at many of the CTD stations. The preserved samples will be returned to J. Gallagher of City College of the City University of New York for identification of phytoplankton populations. One objective of this program is to determine if there are phytoplankton population differences associated with the variety of surface water masses observed in this area.

2- <u>Underway work</u>: The ship's RD Instruments' ADCP

(Acoustic Doppler Current Profiler) whose data are logged with GPS (Global Positioning System) and Gyro readings, provided a valuable view of the currents of the upper 200 to as deep as 400 meters, depending on sea conditions. The ADCP was set to average data in 16 meter bins at two minute intervals. 144 XBT (T-7) probes with a hand launcher provided views of the thermal structure along the track down to approximately 800 meters. Surface characteristics- SST, wind were recorded in ships logging system. Surface salinity was monitoring using the Lamont SeaCat CTD placed in a bucket filled with running stream of water from the ships uncontaminated sea water supply. The bridge recorded the daily list of activities and meteorological conditions.

3- <u>Satellite Sensors</u>: In addition to the observations made form the ship and the time-series collected by the **BEST** mooring array, it is worth noting that the satellite TOPEX/POSEIDON provides altimeter data (sea level measurements to an accuracy of better than 5 cm) at 10 day intervals. These data sets will allow for a time series view of the complex transient spatial scales of the region. NOAA infrared satellites may also be helpful, as surface temperature patterns are expected to relate to circulation and eddy features. The European Research Satellite, ERS-1 altimeters and Ir. sensors may also be useful.

[B] The Operation:

<u>1- CTD operation</u>: We were presented with two options for setting up our CTD data acquisition and data processing system. Ordinarily, CTD operations are controlled from the Main lab adjacent to the computer room and scientific chart area. The ADCP, Simrad, underway data and winch monitor systems are all located in one corner of this lab. To set up in the Main lab would have placed our CTD deck equipment too far from the winch monitor and navigation display, so we chose to set up in the Deck lab, close to the monitors there. In retrospect, it would have been better to stay in the Main lab, since under most underway conditions the Deck lab is a bit of a wind tunnel and is a high traffic area. Overall, though, the Deck lab is a reasonable place to work and provides ready access to the deck areas for CTD and XBT work. There is no GPS readout in either the Main or Deck labs. As a result, our navigation log is an ungainly mixture of satellite navigator fixes, GPS fixes obtained by phone or radio from the bridge, and GPS average positions from the computer which run 3 minutes behind. Andrew Cormack provided us with a complete navigation file, which we will use to adjust all of our navigation and time entries.

The LDEO CTD system consists of a NBIS MKIIIb CTD/O mated to a General Oceanics 24 position rosette sampler. An aluminum frame provides mounting points and protection for the CTD and rosette systems. For this cruise, 1.7

liter bottles were used. Bottom detection on deep casts relied on a passive Benthos pinger tuned to 12 KHz, whose traces were detected by the on board Simrad system. Deck operations were very smooth. The movable gantry and skill of the winch operators made handling the CTD very simple. The traction winch seems to require heavy packages to work properly, so 50kg of lead in two ingots was added to the CTD frame to allow faster veer rates. The conducting cable was already terminated in a stainless steel thimble and wire clips so we decided to use that termination instead of our own (low melting temp alloy potted shell and clevis).

During set up and trial of the CTD deck unit we discovered that our deck unit power supply could not provide adequate power down the wire. When disconnected from the wire, the deck unit functioned normally, so we began to suspect an inability to cope with the ship's power system. No spare was available, and repair deemed unlikely. We returned to Cape Town to pick up a deck unit kindly lent to us by Sea Fisheries Research Institute. Time lost was approximately 6 hours. However, the SFRI deck unit wouldn't work either, so we proceeded with the station plan using SBE seacat recording data internally and tripping rosette by wire out. Meanwhile, Bernie Woodley attempted to troubleshoot our deck unit power supply. During his efforts, the power supply began working again, so we began using the NBIS CTD with the SBE attached to the frame as a backup.

During CTD 15, the signal was lost. It was later determined that the conducting cable had shorted, so 100m was cut off, and the cable re-terminated. During station 17, the CTD began to fail. The CTD deck unit power supply was putting out 180V instead of 150V and could not be adjusted. B. Woodley and M. Stern traced the SFRI deck unit power supply problem to a faulty solder joint and repaired it. However, the SFRI deck unit demodulator would not work in spite of board replacements from our stock of spare parts. Ultimately, the SFRI deck unit was wired to provide power to the sea cable, with our deck unit serving only to demodulate the signal. Our second CTD was put into service to replace the failed unit. This configuration has lasted for the remainder of the cruise.

<u>2- Salinometer</u>: Two Guildline salinometers were set up in the controlled temperature (CT) lab. Temperature stability there is excellent and the salinometers performed very well as a result. A control on the CT unit burned out at one point, filling the CT lab with acrid smoke and shutting down the CT unit. Initially it was feared that there were no spares for the burned unit and we would therefore have lost temperature control. Ordinarily, the salinometers can deal with ordinary environmental control variations, but there is no other ventilation in the CT lab, so if the CT unit fails, the room can no longer be used. Some means of providing

ventilation from the ship's environmental systems should be provided in the event of CT failure. Fortunately, the engineering department had the CT unit back on line within 2 hours of the failure and our program was not affected.

3- Oxygen Titration: Dissolved oxygen concentration from water samples was determined by modified Winkler titration. LDEO titration apparatus was set up in the chemistry lab. Though our chemistry program is minimal we note a number of problems with the chemistry lab. To provide the approximately 5 liter/day deionized water requirement, ship's tap water was run through a deionizing column. Particulates in the tap water severely clogged the DI column after 1 week. Clean water was obtained from the engineering department who drew supplies directly from the ship's evaporators, allowing us to use our second DI column for the remainder of the cruise. A clean water system or at least a filter would be a welcome addition to the chemistry lab. Cleaning and drying glassware is difficult since there is no glassware drying rack in the lab. There is no convenient storage with easy access for hazardous chemicals; nothing to clean up spills. Flume and eye wash facilities are inadequate. It is recommended that a experienced sea-going chemist evaluate the lab and suggest improvement that may be implemented during the 1993 re-fit.

4- Expendable Bathythermograph: For XBT operations we chose to install our own digitizer and computer rather than using the vessel's Bathysystems SA810. We used the NERC hand launcher and cable, and were assisted by Bernie Woodley in making the necessary connections to our unit. After launching 49 XBT's, we discovered a temperature offset of the XBTs relative to the CTD of -1.1C. This was traced to having our XBT system and the ship's SA810 installed simultaneously in parallel. The ship's SA810 was disconnected and the offset disappeared. Close inspection of the XBT data revealed noise indicative of grounding problems which were subsequently traced to a ground loop in the ship's XBT cable installation. The XBT cable shield was grounded at the junction box in the bosun's locker and at the XBT deck unit. After notifying NERC technical staff, LDEO personnel disconnected the junction box ground and the noise problem abated.

5- Underway measurements: ADCP logging and system supervision was provided by A. Cormack of NERC/RVS. Signal quality was degraded when heading into swell which caused any significant pitching. On two occasions, the ADCP transducer well had to be bled of air to regain signal quality. Data analysis provided by A. Cormack was prompt and proved very useful during the cruise, especially in identifying eddy structures.

The salinity of the ship's thermosalinograph was not functioning so we rigged the LDEO Seabird SBE19 (Seacat) to serve as an underway salinometer. The seacat was suspended in a plastic bucket, with water siphoned through the conductivity cell. In order to conserve batteries, the computer to seacat cable was modified per manual specifications to provide +10V to the seacat. Initially, this resulted in unstable and noisy conductivity data. Seabird was contacted and they provided a modification to the Seacats which permitted external power to be provided. A. Cormack arranged for logging of the data on the ship's Level A system in parallel with our data logging on a laptop computer. Initial problems with bubbles in the non-toxic sea water supply were eventually solved by adjusting flow rates to prevent the topside tank from either overflowing to vigorously or running too low.

IV Accomplishments:

[A] The Cruise Track:

Anyone viewing the cruise track may question the underlying logic of the seemingly erratic path. But, that is often the result of an observational program aimed at surveying a transient, complex field of eddies amidst branching current systems. Some components of the track are 'well-behaved' such as the sections along the **BEST** 30°S and southern mooring array. Between these arrays is the eddy survey phase of the cruise, the track and station plan varies as the real time data stream reveals the nature of the beast being explored. TOPEX/POSEIDON satellite altimeter data prior to the cruise provided a target for the eddy search, though not enough specifics to allow for a dependable pre-cruise track plan.

[B] The Station Array:

The distribution of CTD stations and XBT observations (Fig. 2 map view of CTD and XBT stations and Table 2, at the end of this report) may be divided into specific elements:

1- 30°S section, (CTD Stations 2-18) in support of the moored instrument array and provide a value for Benguela Current transport and water mass composition;
2- the Walvis Ridge survey, (CTD Stations 19-32 and XBT grid) to inspect for effects of the Walvis Ridge on the mean circulation and eddy field;
3- Agulhas Eddy Survey, (CTD Stations 33-58 and XBT grid) to survey the thermohaline and dynamic form of the resident eddies The long NW-SE line of XBT is along a TOPEX/POSEIDON satellite altimeter line. This will allow for direct comparison of the thermal and ADCP data with sea level as detected by the satellite.
4- the Southern IES Mooring and transit line to the southern moorings (CTD Stations 59-74) in support of the moored instrument array and to inspect for streams of South Atlantic Current and Agulhas Current directed into the Benguela Current, and their relationship to the eddy field.

V Preliminary results:

[A] Brief summary of major results of R.R.S. Discovery 202:

1- The eddy array is composed of eddies of different, scales, ages and sources. A possible Brazil Current eddy was observed near the Walvis Ridge. Three Agulhas eddies were explored: a winter altered eddy between 30° and 33°S near 6°E; a eddy not yet experiencing a winter between 32° and 34°S near 9°E; and a vigorous newly formed eddy centered near 37°S and 15°E.

2- The Agulhas eddies are carriers of Indian Ocean water, but they also determine the ratio of Atlantic to Indian contribution to the Benguela Current. The eddies direct streams of regional current systems (South Atlantic Current and Agulhas Current) around their periphery into the Benguela Current where these water masses blend and spread into the interior of the South Atlantic.

[B] Specific Comments:

1- 30°S section: 21 bottom reaching CTD stations were taken along 30°S. These data provide a cross-cut of the water masses and density field of the Benguela Current. Comparison with the moored instrumentation data will allow for their calibration and improve their interpretation. The ADCP may be used as geostrophic reference for the density field, providing for a more complete picture of the Benguela transport. The thermohaline stratification is composed of South Atlantic and Indian Ocean water types.

2- Walvis Ridge: As the CTD station line turned south upon completion of the 30°S section, filaments of a homogeneous layer with a temperature near 13° C were observed. It was suspected that an eddy with such core properties was in the area, perhaps being dissipated by through interaction with the Walvis Ridge. An XBT search revealed the existence of such an eddy near 34°S and the Greenwich Meridian. The eddy measures 130 km in diameter. The 10°C isotherm, which closely correlates with the sea surface dynamic topography, dips from the regional depth of 450 meters to 620 meters in the eddy center. The ADCP current values at 250 meter within the eddy rim is 30-40 cm/sec. At the eddy center is a nearly 400 meter thick homogeneous layer of 13.1°C and 35.21 ppt water. The T/S point of this water is salty compared to the region T/S relationship and high in oxygen. This is a clear indication of cooling with significant evaporation of subtropical thermocline water trapped within an eddy core. It's low temperature makes it unlikely that the core water comes from the Agulhas. However, the eddy core does match that observed within Brazil Current eddies in the Argentine Basin. While similar water has been detected within the South Atlantic Current, and attributed to the Brazil Current eddies, this is the first evidence for the specific dynamic form of a Brazil eddy well east of the Argentine Basin.

3- Agulhas Eddy Survey: Two eddies were observed: at station 34-36 and one centered near 33°S and 9.3°E, where a detailed survey was carried out. A third Agulhas eddy is explored along the southern mooring region and is discussed below. Station 35 is in a well developed eddy of Agulhas origin, as indicated by its core properties, 15-16°C, with positive salinity and oxygen anomalies. The temperature is a bit cooler than the Agulhas Retroflection source water indicating that station 35 central core has been cooled by winter conditions. The nearby small eddy centered at 32.5°S 9°20'E with a diameter of 160 km has a homogeneous layer of 17.5°C at its core. This water is identical to that found within the Agulhas Retroflection, suggesting that this eddy has not yet endured a winter. Two eddies so close in space but with such difference ages indicates that the western 'lead' eddy must have slowed, presumably in response to the shallow segment of the Walvis Ridge to its immediate west. This stalling phenomena has been detected with the Geosat altimeter during the 1986-1989 period, our field data confirms it. Station 53 near the center of the eastern eddy shows a unique deep layer, near 9°C, with much reduced vertical gradient from 650 to 850 m. The base of this layer shows as a strong positive salinity anomaly and low oxygen, hence a tropical thermocline origin is suspected, but is it tropical Atlantic or Indian? Often filaments of tropical Atlantic water (which is picked up eddy interaction with the African continental slope) are observed along the eddy rim, but never within the eddy core.

4- Southern IES Mooring: The north-south line of CTD (58 to 66) and XBT extending from the eddy survey to the southern moorings. A shallow 10°C (less than 300 m) feature was crossed near 35°S. We then entered into the northern edge of an intense Agulhas eddy around stations 63 to 64 (35°-36°S). The mixed layer within the eddy center was about 150 deep, and appears to be the subtropical mode water of the Agulhas Retroflection which has been exposed to the late Fall atmosphere. Presumably, cooling of this water to 15°-16°C may be expected during the coming winter months. We again sampled the eddy with station 69, and it's edge with station 70. After station 70 at 15°E a short 4 hour 'jog' to the south was followed before going to station 71. XBTs showed a 750 m 10°C isotherm south of the mooring line. This 'Southern mooring eddy' is in a position of an eddy surveyed in 1983 (called the Cape Town Eddy), and at least once since that time. Might there be a quasi-stationary Agulhas eddy in this position much of the time? The ADCP reveals the presence of a strong flow of South Atlantic origin heading to the northeast between the 9°20'E eddy and the rim of the 'Southern mooring eddy'. A strong stream (>90 cm/sec) of Agulhas water is directed counter-clockwise around the eddy. The eddy may also direct additional

Agulhas water to the north between it and the mainland. Agulhas and South Atlantic current streams merge to form the contents of the Benguela Current. These streams may change with the distribution of the eddy field configuration, and with it the contribution of Indian water into the South Atlantic. Comparison of the inflow, as defined by CTD and ADCP, across the southern mooring line and line of stations traversing the region from the eddy survey to the western end of the southern mooring line will allow excellent control over calculation of the contribution of South Atlantic and Agulhas waters to the Benguela Current, one of **BEST** primary objectives.

VI Comments and Acknowledgments:

The facilities aboard the R.R.S. Discovery and its staff of dedicated professionals provide for superb support of the science mission. If science objectives are met, then science money is efficiently spent. The NERC Research Vessel Services operation maximizes science return.

The ship Master, Mike Harding, made a special effort to see that we were comfortable and able to carry out our observational program. The entire staff of the ship endeavored to make it so. General living conditions (accommodations and food service) are excellent (the best I've experienced on a research vessel). The NERC technical staff were extraordinary helpful and competent, cheerfully ready to do their work at any time. RVS are to be congratulated in putting together such a fine team!

The nature of searching for specific features and exploring their form require much flexibility of the observational plan. This involves preparation of a preliminary track to provide some idea of the scope of the data collection strategy. But it also requires frequent alterations of this plan as the data set grows and points towards specific opportunities. As Chief Officer Roger Chamberlain says- 'that's what science is all about, discovery, that's what we are here for'. The complete cooperation and understanding of the Bridge officers to the frequent changes in cruise plan is much appreciated.

The ship ADCP was a pleasant surprise. With proper averaging it will prove to be a valuable asset in interpreting the CTD and XBT data set. ADCP data analysis provided by Andrew Cormack was prompt and proved very useful during the cruise. A. Cormack arranged for logging of the data on the ship's Level A system in parallel with our data logging on a laptop computer. He is a most knowledgeable, helpful and pleasant person; a credit to RVS.

Bernie Woodley help with the CTD power supply problem and other 'electronic' issues was important in insuring the success of our project. The valuable help of the entire

NERC/RVS technical staff is greatly appreciated.

A number of facility items are mentioned in Section III above. These are briefly repeated here:

° There is no GPS readout in either the Main or Deck labs. GPS fixes obtained by phone or radio from the bridge, and GPS average positions from the computer which run 3 minutes behind. Real time GPS readouts in the working labs is suggested.

° The chemistry lab needs some attention. I suggest a sea-going chemist evaluate it and recommend improvements in terms of storage and safety.

° The salinity component of the ship's thermosalinograph was not functioning. Such data are important, as salinity is perhaps the best means of identifying fronts. It is further noted that there is growing awareness of the need surface salinity data in ocean research. The full thermosalinograph system should be operational.

° Some means of providing ventilation from the ship's environmental systems should be provided in the event of controlled temperature lab failure.

° Provide one or two color Macintosh computers for the computer lab. They are good for word processing, graphics and often the choice of the average computer user (like me) than the UNIX and DOS machines presently available.

Figure 1

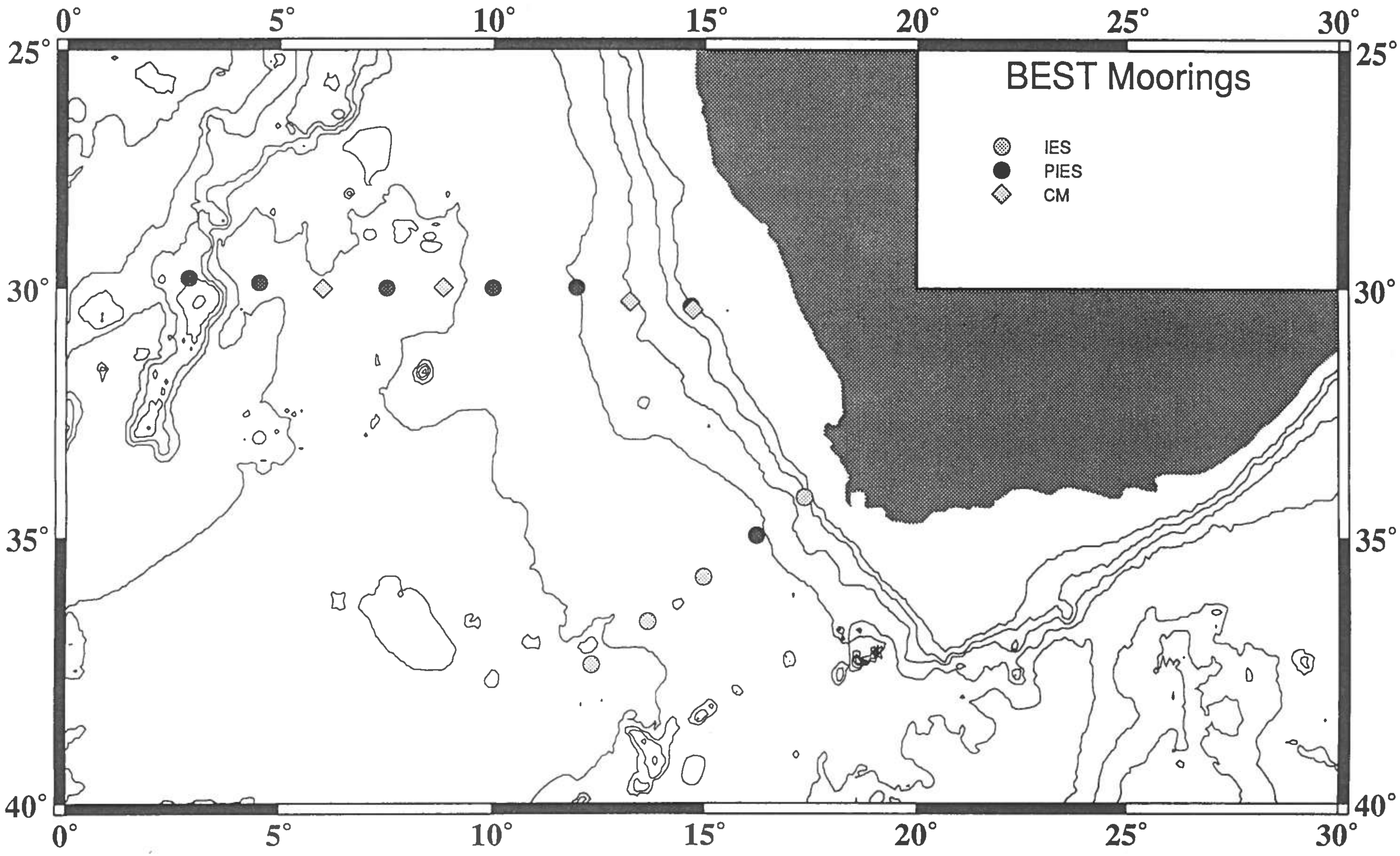

fig 1

Figure 2

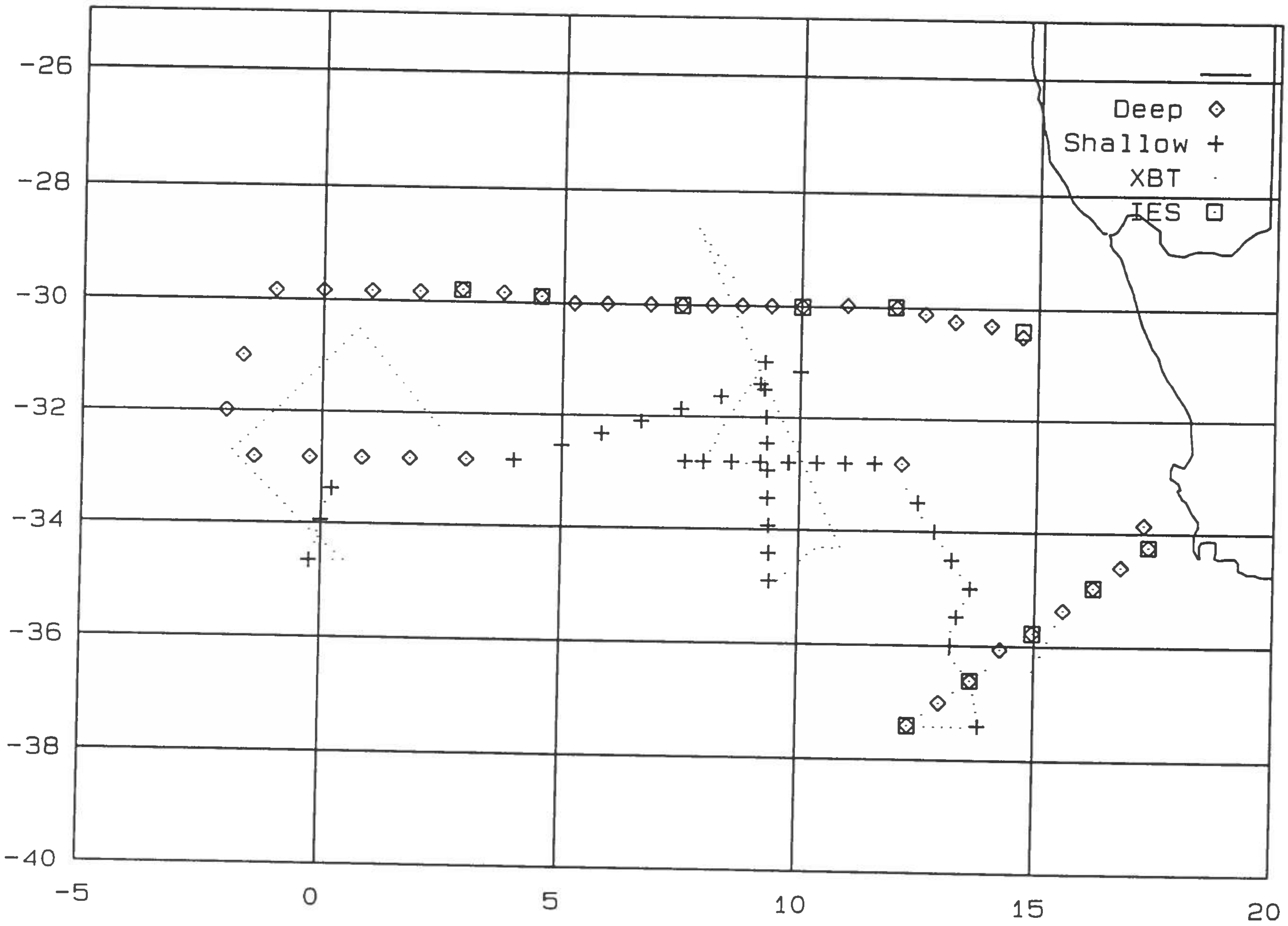

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Table 2 CTD Stations

station numbers in bold are bottom reaching stations, all others are to 1500 meters; all stations were taken with the NBIS MKIIIb CTD/O & G.O. rosette, except where SeaCat was used, denoted by 'SBE19'

Station #		Latitude	Longitude	Date	Time	Notes
1	.	-33.8605	17.2525	93/05/07	17:40	SBE19
2	+	-30.4885	14.6652	93/05/08	14:48	SBE19
3		-30.3000	13.9967	93/05/08	19:39	
4	+	-30.2360	13.2395	93/05/09	01:43	
5	+	-30.1089	12.6068	93/05/09	08:32	
6	+	-30.0000	12.0000	93/05/09	15:13	
7		-29.9974	10.9971	93/05/10	23:36	
8	+	-30.0000	10.0000	93/05/10	07:20	
9	+	-30.0002	9.3662	93/05/10	14:17	
10	+	-30.0000	8.7500	93/05/10	22:30	
11	+	-30.0000	8.1111	93/05/11	05:51	
12	+	-30.0063	7.4962	93/05/11	13:09	
13	+	-29.9983	6.8333	93/05/11	21:20	
14	+	-29.9430	5.9250	93/05/12	05:59	
15		-30.0005	5.2337	93/05/12	13:33	cable problems
16		-29.8885	4.5478	93/05/12	21:35	SBE19
17		-29.8327	3.7352	93/05/13	05:15	CTD failed on uptrace
18	.	-29.7882	2.8750	93/05/13	13:15	SBE19
19		-29.8337	2.0015	93/05/13	20:20	SBE19
20	+	-29.8335	1.0023	93/05/14	04:05	Switch to CTD 2809
21	+	-29.8369	0.0023	93/05/14	11:31	
22		-29.8200	-1.0122	93/05/14	19:18	
23	+	-30.9945	-1.6623	93/05/15	05:52	
24	+	-32.0031	-1.9976	93/05/15	14:43	
25	+	-32.8332	-1.4214	93/05/15	22:26	
26	+	-32.8358	-0.2522	93/05/16	07:11	
27		-32.8314	0.8344	93/05/16	13:54	
28	+	-32.8322	1.8297	93/05/16	22:02	
28		-32.8322	1.8297	93/05/16	23:05	
29	+	-32.8360	2.9941	93/05/17	05:19	

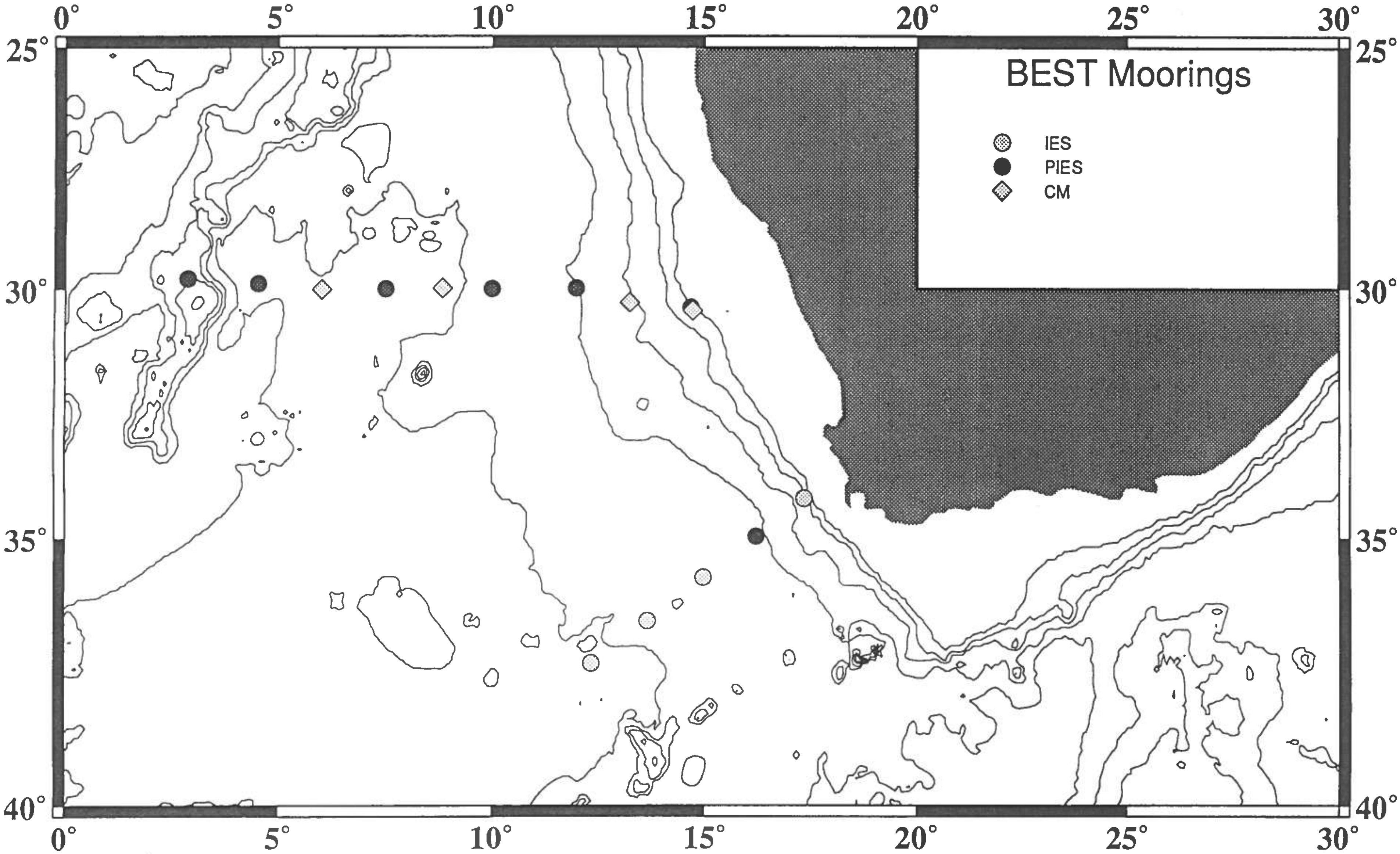
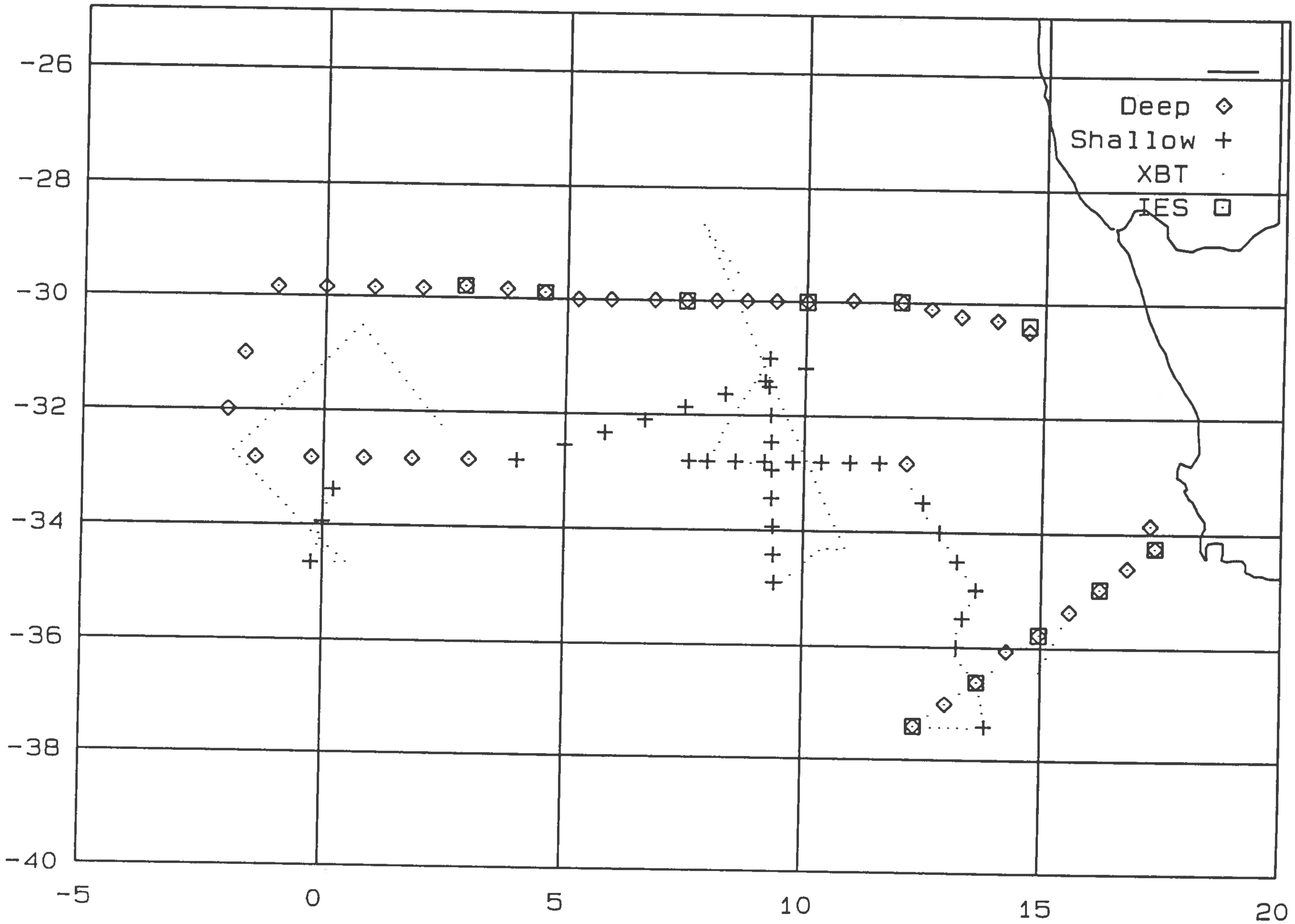


fig 1



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30		-34.6543	-0.2403	93/05/19	09:20
31	+	-33.9378	-0.0087	93/05/19	14:58
32	+	-33.3888	0.2067	93/05/19	19:44
33		-32.8294	3.9913	93/05/20	18:59
34	+	-32.5587	5.0004	93/05/20	22:15
35	+	-32.2326	5.8313	93/05/21	03:44
36	+	-32.0975	6.6648	93/05/21	09:20
37		-31.8664	7.4972	93/05/21	15:09
38	+	-31.6527	8.2969	93/05/21	21:14
39	+	-31.4046	9.1515	93/05/22	02:46
40	+	-31.1666	9.9976	93/05/22	08:52
41		-34.9078	9.3998	93/05/24	16:58
42	+	-34.4186	9.3789	93/05/24	21:43
43		-33.9300	9.3600	93/05/25	02:26
44	+	-33.4500	9.3400	93/05/25	06:54
45	+	-32.9555	9.3209	93/05/25	11:14
46		-32.4692	9.3029	93/05/25	15:36
47		-31.9970	9.2874	93/05/25	20:08
48	+	-31.5013	9.2686	93/05/26	00:41
49		-30.0000	9.2500	93/05/26	05:26
50	+	-32.8054	7.3808	93/05/26	22:33
51	+	-32.8166	7.9797	93/05/27	03:11
52	+	-32.8160	8.5661	93/05/27	07:29
53		-32.8142	9.1677	93/05/27	12:05
54		-32.8157	9.7650	93/05/27	16:53
55		-32.8167	10.3570	93/05/27	22:00
56		-32.8161	10.9522	93/05/28	01:46
57		-32.8157	11.5481	93/05/28	06:26
58	+	-32.8156	12.1427	93/05/28	11:20
59		-33.4959	12.4934	93/05/28	19:59
60		-34.0000	12.3585	93/05/29	02:15
61		-34.4986	13.2336	93/05/29	07:57
62	+	-35.0000	13.6339	93/05/29	13:36
63		-35.5000	13.3522	93/05/29	19:43
64		-35.9990	13.2329	93/05/30	01:58
65	+	-36.6102	13.6648	93/05/30	08:11
66	+	-37.4042	13.8356	93/05/30	19:16

67	+	-37.4027	12.3483	93/05/31	05:12	
68		-37.0076	13.0066	93/05/31	12:13	
69		-36.7170	14.3076	93/05/31	23:44	
70	+	-35.7762	14.9575	93/06/01	07:09	
71	+	-35.3738	15.5927	93/06/01	20:46	
72	+	-34.5800	16.1200	93/06/02	04:10	estimate
73	+	-34.3700	16.4400	93/06/02	11:00	estimate
74	+	-34.1500	17.2000	93/06/02	15:00	estimate

+ in 2nd column indicates plankton sample at this station