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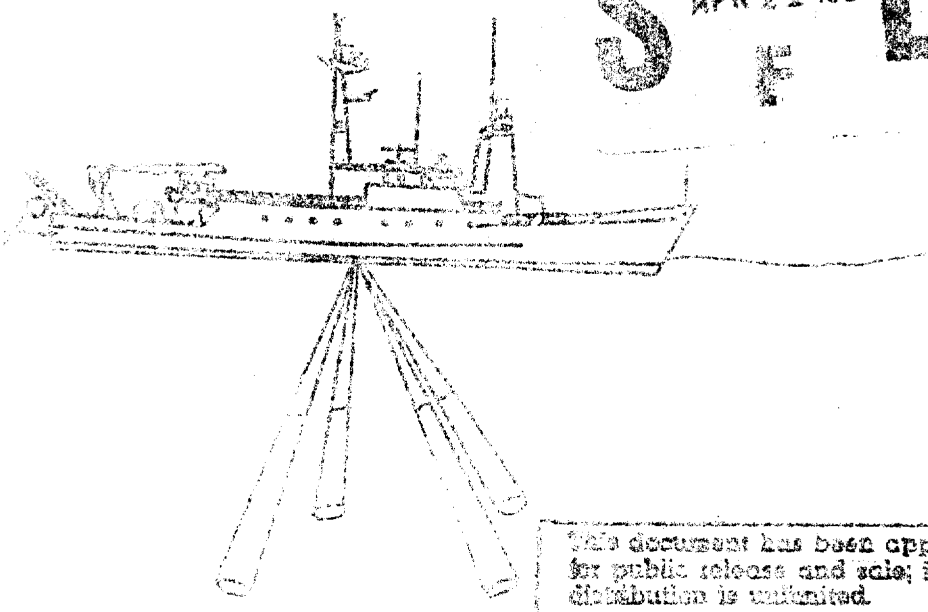

Oregon State University

SeaSoar and CTD Observations During a COARE Surveys Cruise, W9211C, 22 January to 22 February 1993

by

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Fine- and Microstructure Observations at Fieberling Guyot
R/V *New Horizon* Cruise Report

by

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November 1993

Technical Report

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Abstract

This report describes fine- and microstructure profile data taken on a cruise to Fieberling Guyot, a seamount in the northeast subtropical Pacific Ocean. The work performed at sea, instruments used, data return and processing procedures will be summarized here. This cruise took place between March 4 and March 28, 1991 on the *R/V New Horizon*, and was part of the interdisciplinary Accelerated Research Initiative (ARI) for Abrupt Topography sponsored by the Office of Naval Research. An overall goal of the ARI was to understand the physical, biological, and geological processes occurring near a seamount.

The scientific objective of the Seamount Mixing Cruise was to collect data describing the oceanic fine-scale velocity and density fields, as well as the related turbulence and mixing in the vicinity of the seamount. The High Resolution Profiler (HRP) was deployed 95 times above and around the seamount. As well, two test dives were conducted on the way to the site, and eight deployments completed in deep basins off the southern California coast before returning to port. Three near-synoptic surveys of the seamount were completed with the deployment of 128 Expendable Current Profilers (XCP's). The temperature field of the upper 760 meters of water within a 50 kilometer radius of the seamount was mapped using 144 Expendable Bathythermographs (XBT's).

Overview

The Seamount Mixing Cruise to Fieberling Guyot took place in March 1991 on the *R/V New Horizon*. The objective of the cruise was to study the oceanic fine-scale velocity and density fields, as well as the related turbulent mixing in the vicinity of abrupt topography. In the past decade, interest in the role boundaries play in oceanic mixing has increased significantly. Several mechanisms for enhanced flow and mixing at or near a seamount have been forwarded. Bottom stress resulting from flow past a seamount might generate turbulence which, in turn, could create bottom mixed layers. These layers might subsequently detach from the slope and drift off into the interior. An alternative theory suggests that various forms of waves could be trapped by or reflected off the sides of the seamount. The purpose of our cruise to Fieberling Seamount was to sample the fine-scale velocity field around the seamount, document the related turbulent velocity and temperature fields, and identify the causes and intensity of the mixing.

The Fieberling Seamount was chosen as the study area for the Abrupt Topography Accelerated Research Initiative (ARI) for two main reasons. First, it is an isolated seamount with steeply sloping sides, the top of which is flat, and extends to 500 meters beneath the surface. This topography was appropriate to the needs of the biology and physical oceanography programs as it was expected to define a relatively simple system, making data interpretation easier. Second, Fieberling Seamount is a two-day transit from San Diego. The proximity to port and the Scripps Marine Facility minimized travel time, and simplified the logistics of cruise staging. Figure 1 shows the location of Fieberling Seamount in relation to the California coast. The figure's inset shows the bathymetry of the seamount.

Six months prior to our cruise several current meter moorings were deployed on the seamount by C. Ericksen and K. Brink, also as part of the Abrupt Topography ARI. These moorings were instrumented to collect time series data in the waters above and around the seamount for an 18-month period. The moorings set within our area of operations were the "C" (central) mooring located on the top of the seamount, and the F3 (flank 3) mooring located at 1450 meters on the southwest flank of Fieberling. The data from these moorings and the data gathered on our cruise will be used to describe the processes occurring at the seamount.

Our group was primarily interested in observing the physics of the mixing that occurs as a result of flow over and around the seamount. To this end, two main instrument systems were employed on the cruise, the High Resolution Profiler (HRP), and Expendable Current Profilers (XCPs). The HRP returned profiles of fine- and microstructure data at various locations on the top and flanks of the seamount in the form of time series (repeated deployments at fixed sites), as well as transects from seamount center to the surrounding abyssal plain. The HRP is able to sample close to the bottom because of its onboard range-finder. Some of the features we hoped to observe occur within 20 meters of the seamount, so the HRP profiles were terminated as close to the seamount as possible, without risking damage. The HRP's features also allowed data collection to abyssal depths. A survey of the base of the seamount included microstructure profiles to 3000 meters depth: a first for this kind of measurement.

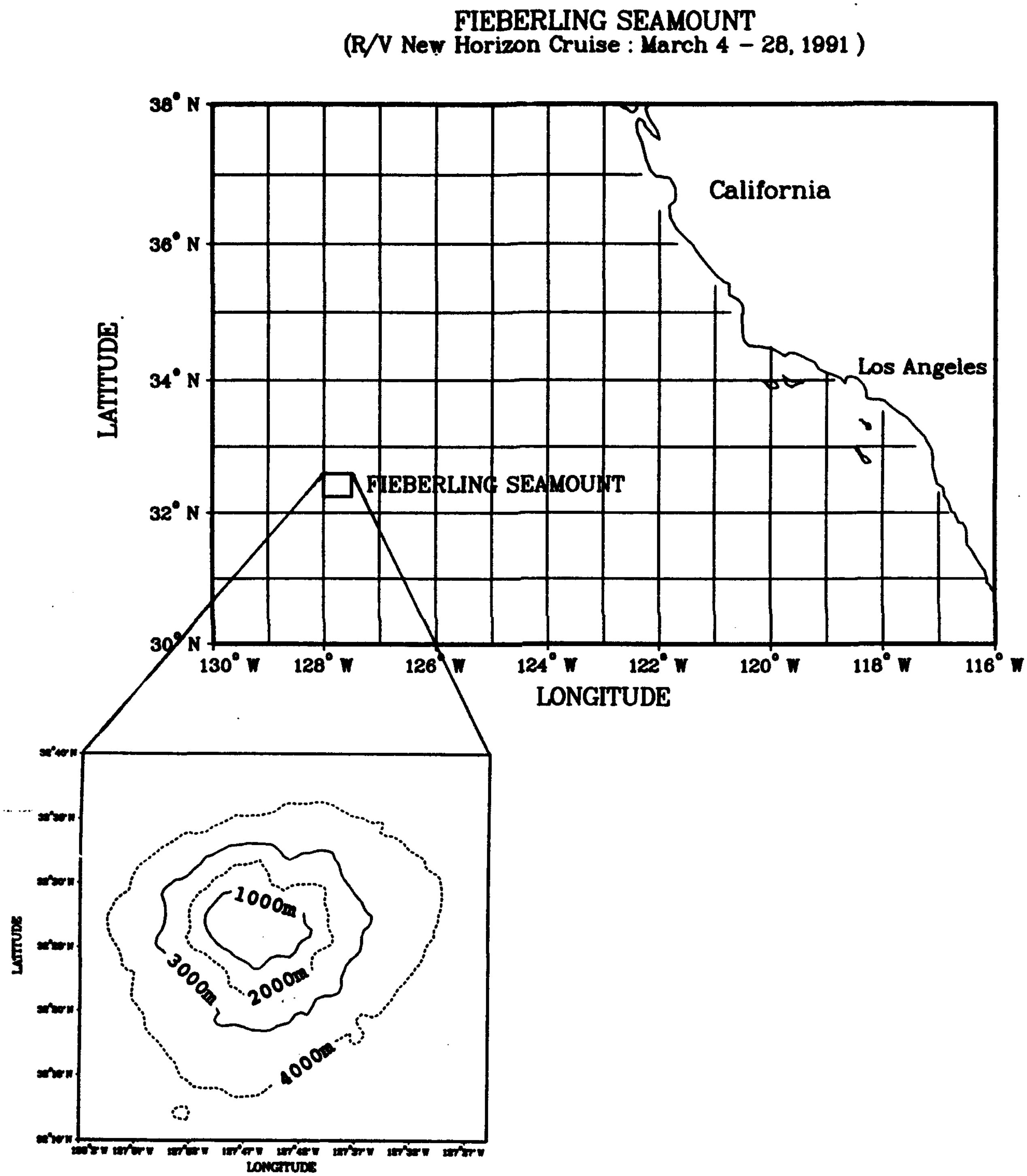

Figure 1: Chart showing the location of Fieberling Seamount. Inset shows detail of the topography.

The XCP's were used to survey the velocity and temperature fields of the upper 1500 meters of the ocean. The XCP surveys were done underway, so near-synoptic horizontal resolution was achieved. These observations were augmented by Expendable Bathythermograph (XBT) temperature measurements and ADCP (Acoustic Doppler Current Profiler) underway velocity data.

The work of the cruise is described in chronological order in the following section. Figure 2 provides a time event diagram showing the sequence of work done during the cruise, by instrument type. This figure can be referred to when reading the cruise log. The HRP is described in the instrumentation section of this document because it is a one-of-a-kind instrument. XCP's and XBT's are commercial products with a broad user base, so are not described here. For more information on XCP's and XBT's, contact the manufacturer: Sippican Corporation, of Marion, Massachusetts. Next, the shipboard data analysis procedures are outlined in the Data Processing section. The last section of this report summarizes the work completed.

The science party for this cruise on the *R/V New Horizon* consisted of employees of the Woods Hole Oceanographic Institution and the University of Washington. The participants, their institutional and instrument affiliations are listed below.

Scientist	Employer	Instrument
Art Bartlett	U. Washington/APL	XCP
Maggie Cook	WHOI	HRP
Dick Koehler	WHOI	HRP
Eric Kunze	U. Washington	XCP
Ellyn Montgomery	WHOI	HRP
Kurt Polzin	MIT/WHOI Joint Program	HRP
Ray Schmitt	WHOI	HRP
John Toole	WHOI	HRP, Chief Scientist
Dave Wellwood	WHOI	HRP
Susan Wijffels	MIT/WHOI Joint Program	HRP

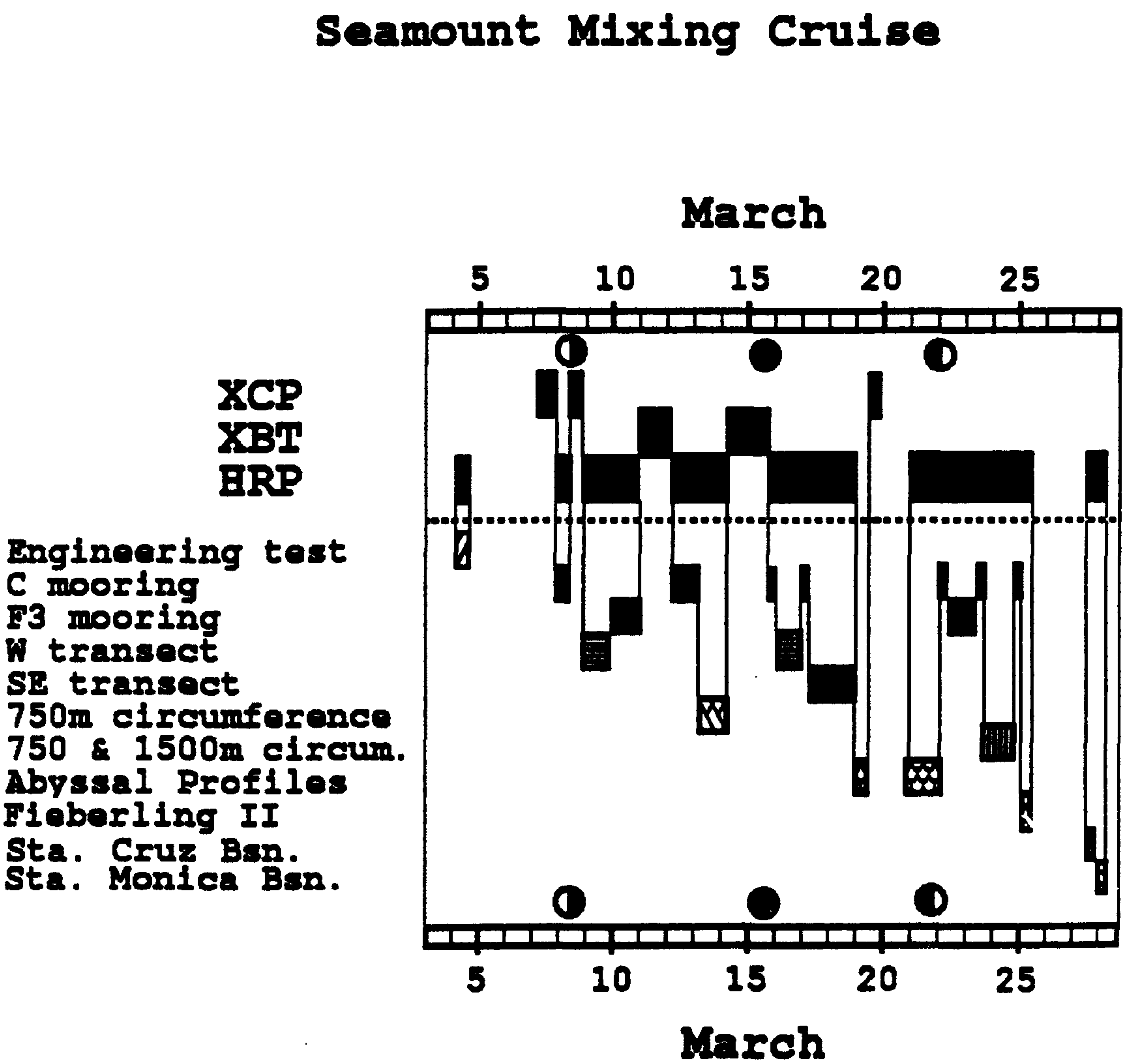

Figure 2: A time – event diagram of sampling during the Seamount Mixing Cruise. A breakdown of the HRP sampling appears below the dotted line. Phases of the moon are also shown.

Cruise Log

The *R/V New Horizon* departed San Diego on March 4 in fine weather. Our initial work consisted of two test deployments of the HRP in deep water nearshore. The tests showed the HRP was working well, and as our main instrument systems are self-contained, we returned the Scripps marine technician to shore before proceeding west to Fieberling Seamount.

Scientific observations commenced at Fieberling on the morning of March 7 with an XCP survey over the summit and eastern side of the seamount. A radial sampling pattern was occupied twice over the next 12 hours. Figure 3 shows the XCP survey positions superimposed on a chart of the seamount's bathymetry. Care was taken to avoid the area within a one nautical mile radius of the moorings in an attempt to ensure that wire from the expendables, would not foul the current meters. During this survey, 62 XCP's were used. The survey was suspended long enough to complete two HRP drops (numbers 3 and 4) over the top of the seamount. Then 33 more XCPs were used to sample the northwest quadrant of the seamount.

At the conclusion of the first XCP survey on March 8, HRP operations began in earnest. Figure 4 shows the HRP profiles completed on the seamount, and should be referred to when the HRP transects, time series and surveys are described in the following paragraphs. The initial work was a transect consisting of six stations spanning the western flank of the seamount. These stations varied in depth from 500 meters at the summit of the seamount to 2500 meters at the western perimeter. This transect, completed twice in the next 24 hours, is comprised of dives 5 through 10 and 11 through 16. At the completion of the transect work, a series of profiles at the F3 mooring site, in 1500 meters of water, was commenced. This series includes dives 17 through 25 with a deployment at the site every three hours, spanning 24 hours.

On March 10, the weather became too rough for HRP operations, and a large scale XBT survey was begun with 26 deployments southwest of the seamount, shown in Figure 5. After 18 hours the bad weather had abated, so HRP work was resumed.

A series of HRP dives at the Central (C) mooring site was started late on March 11. The C mooring was in the center of Fieberling's summit, in 513 meters of water. HRP profiles 27 through 36 were done at three-hourly intervals over the next 27 hours, yielding 10 dives in this time series. An HRP survey of the 750-meter contour of the seamount was started next. Eleven HRP dives (numbers 37 through 48) were done in the next day, encircling the top of the seamount. A total of 48 HRP dives and 96 XCP drops were completed at this point.

Again the weather deteriorated, and the large scale XBT survey was recommenced. This work occupied March 14 and 15. A total of 87 XBT's were used, with one XBT dropped every 2 kilometers along the survey track.

On March 16, in improving weather, the six-station HRP transect across the western flank was repeated with dives 49 through 53. Then, a transect from the center of the seamount to the southeast was begun. This transect used station spacing comparable to that on the western flank. The southeast transect was done twice in 36 hours with the completion of dives 54 through 59 and 60 through 67.

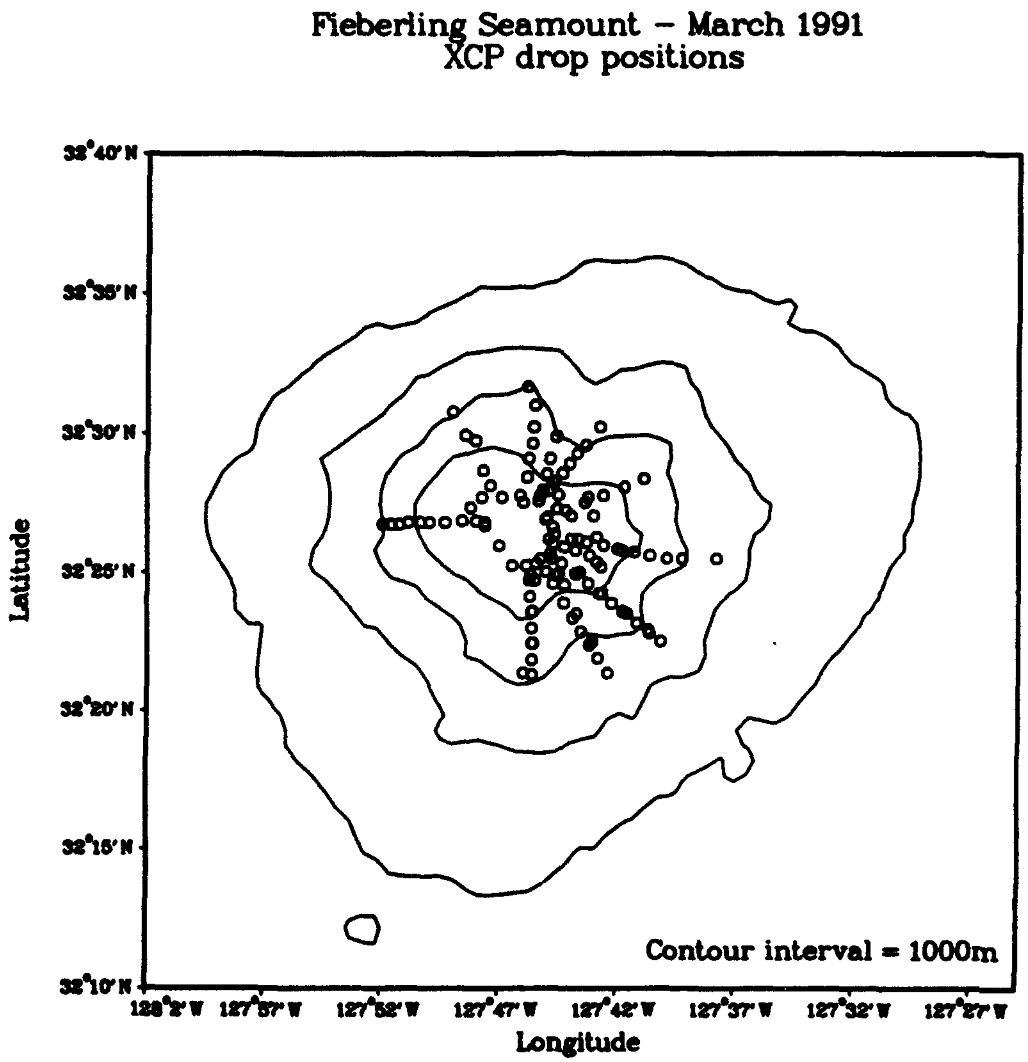

Figure 3: Chart of the seamount with XCP locations plotted.

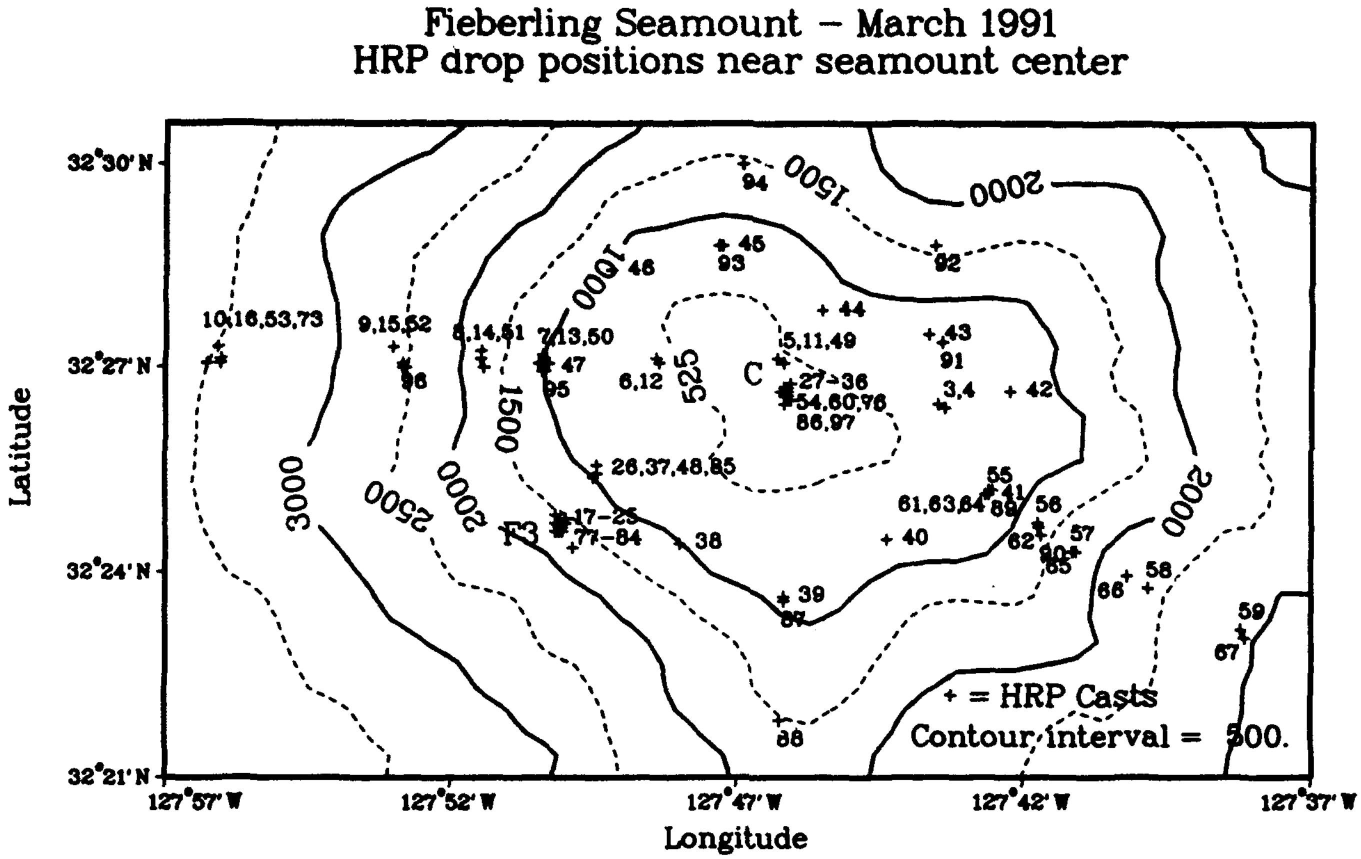

Figure 4: Enlargement of the seamount, with numbered HRP casts shown. (Also marked are the sites of the Central (C) and Flank (F3) current meter moorings.)

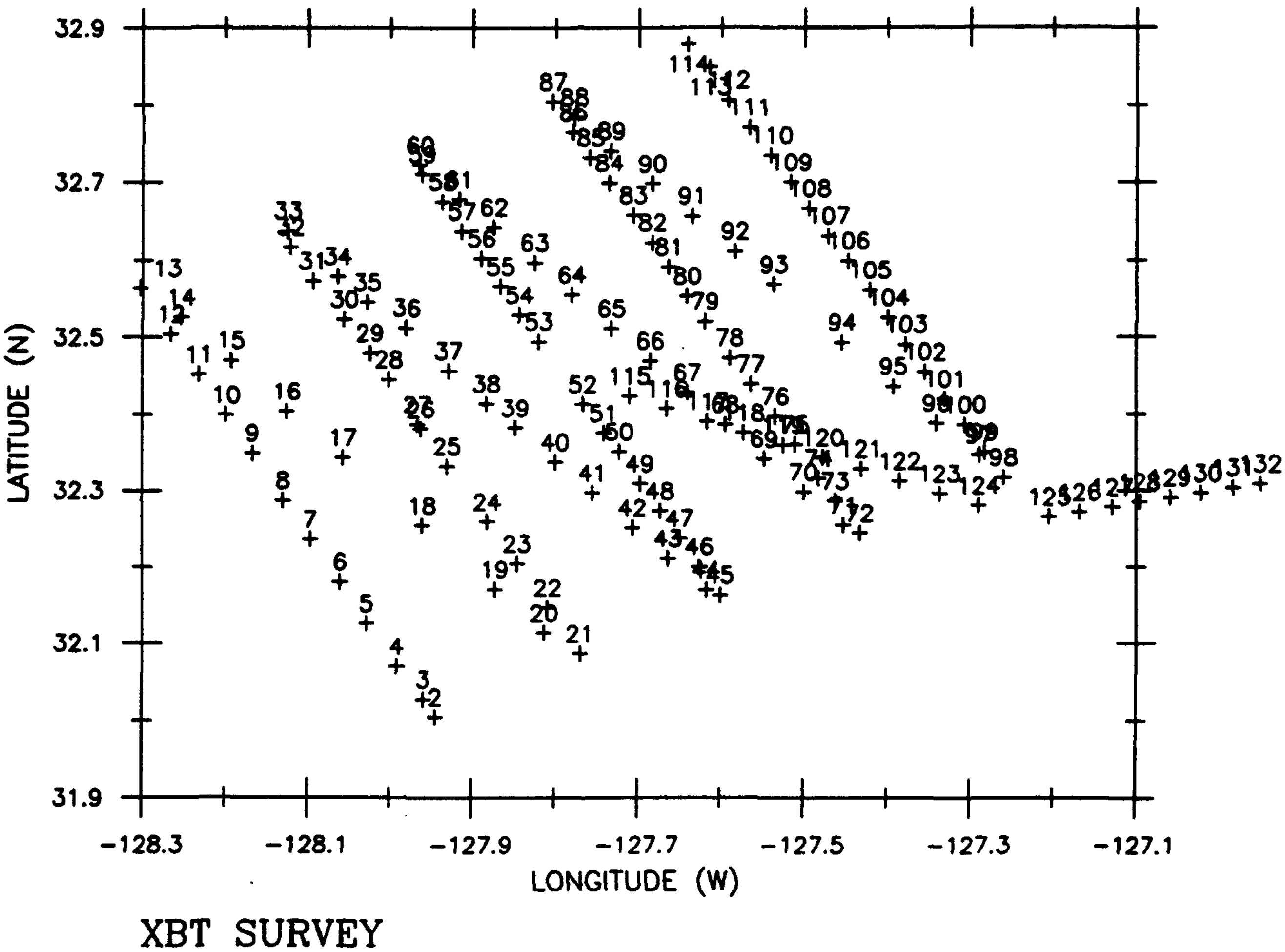

Figure 5: Chart showing the location of XBT deployments in the large scale survey.

Before commencing the second XCP survey (Figure 3) on March 18, an XCP was deployed at the same time a HRP dive was commenced. This intercomparison was a valuable test as the two instruments employ completely different technologies to estimate ocean currents. A high degree of correlation between the two devices is shown in Figure 6. This XCP survey followed the 750 meter contour of the seamount, with an XCP dropped every 2.5 kilometers. The last XCP on the ship was used at 0830 March 18.

Following the XCP survey, the deep water areas surrounding the seamount were sampled with the HRP. Casts were done at 10 and 20 nautical miles from the summit of the seamount in each cardinal direction (N, S, E, W). The water depth in these areas varied between 3500 and 4000 meters, but the dives were terminated at 3000 meters. During this survey, bad weather forced suspension of operations for one 24 hour period. The dives comprising this survey are 68 through 75 and represent some of the deepest microstructure measurements taken at that time.

On March 22, following the deep water HRP survey, an HRP dive at the C mooring site was done, followed by another 24-hour time series at the F3 mooring site (dives 76 through 84). On the second dive of this series the HRP hit the bottom. The minor damage sustained was repaired and the sampling continued. At the end of the time series, a final circuit of the seamount with HRP sampling alternately along the 750-meter and 1500-meter contours was started. With these last deployments at Fieberling Guyot (85 through 96), and a final deployment at the summit, a total of 97 HRP dives were completed, with 120 XCP's, and 155 XBT's used.

Before heading back to land, two HRP deployments were done over the summit of a neighboring seamount, Fieberling II.

The transit from Fieberling to San Diego was started on March 24. Mechanical difficulty caused the trip back to San Diego to be done on one engine. Despite the reduced driving force, a strong tail wind pushed ship speeds to above 8 knots, much in excess of what was initially anticipated. The time gained was used to make exploratory HRP deployments in two deep basins off the Los Angeles coast where J. Ledwell had conducted tracer release experiments. The shipboard supply of ballast weights for the HRP was exhausted by completing four dives in both the Santa Monica and Santa Cruz basins. The *R/V New Horizon* returned to port late in the afternoon of March 28.

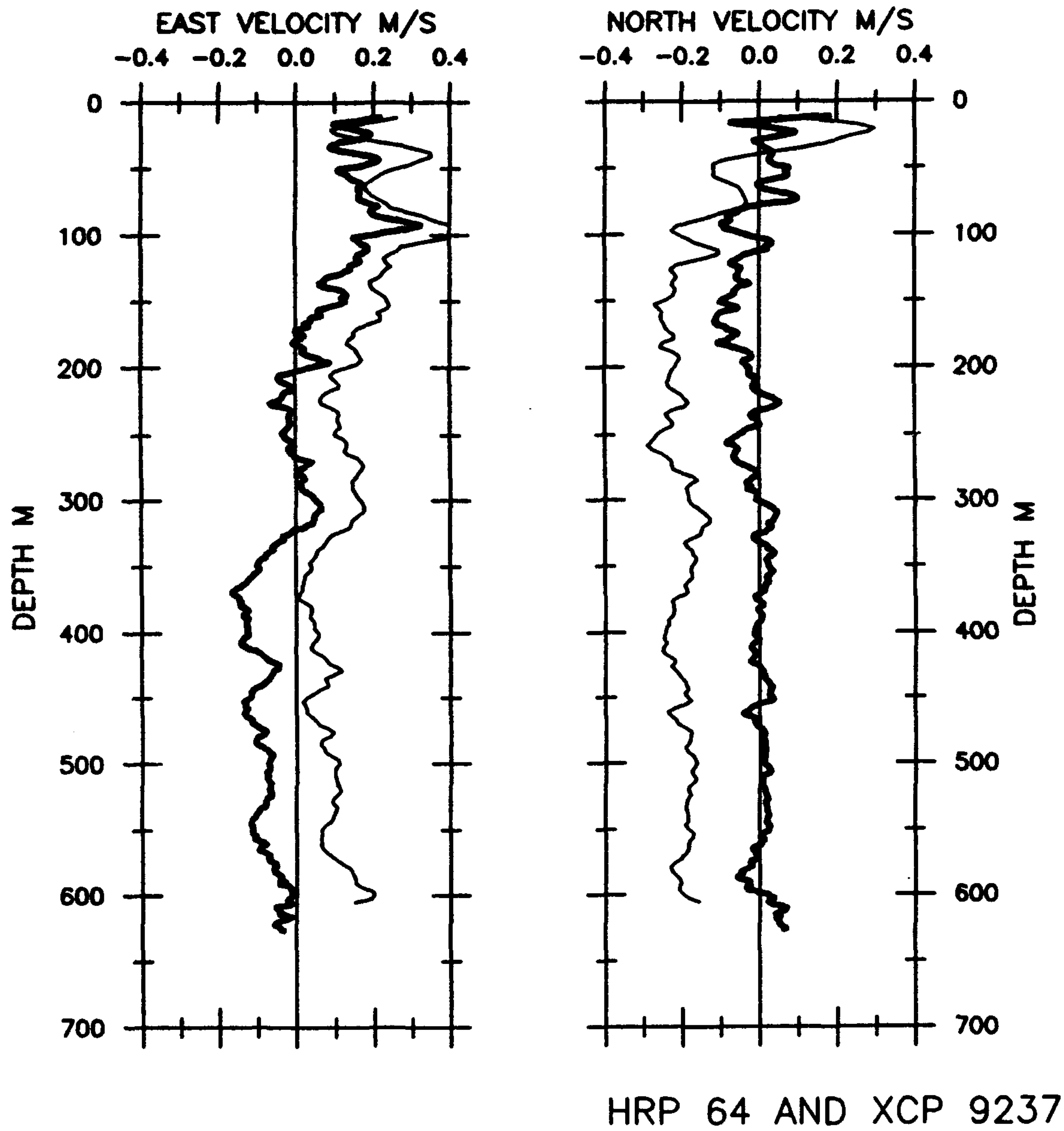

Figure 6: Velocity profile data from simultaneous XCP (thin line) and HRP (thick line) casts (#3297 and #64 respectively). Both profiles are relative, and have been offset for clarity.)

High Resolution Profiler Description

The High Resolution Profiler (HRP) is a vertically profiling free vehicle. This means the HRP collects data as it falls vertically through the water, and it is not attached to the ship while acquiring data. Being a free vehicle, the measurements taken by the HRP are not subject to cable induced noise. Each deployment of the HRP, and the data collected during that deployment, are referred to as a station or profile.

The HRP was designed and developed at WHOI to make high quality fine- and microstructure measurements using the interface bus computer (IBC). The IBC is the HRP's controller, handling everything from software setup to data acquisition and storage. A suite of sensors interfaced to the IBC provide data on the physical properties of the water sampled as the HRP descends. All the data collected is stored internally in a 16 Mb RAM (random access memory) mass storage area. A schematic of the HRP and its components is shown in Figure 7. For additional information on the development of the HRP and IBC, see the papers by Schmitt *et al.*, 1988, and Mellinger *et al.*, 1986.

The HRP has two data streams: "fine" and "micro." The fine-scale data consist of inputs from the on-board CTD (conductivity, temperature, depth sensor), and a suite of analog devices interfaced via the analog to digital (A/D) converter channels. The microstructure sensors consist of two turbulent-scale air-foil velocity sensors, a fast response thermistor, and a dual-needle conductivity probe. During a profile, the microstructure measurements are acquired simultaneously with the finescale data. The sampling in both modes is driven by a 200 Hz interrupt, with micro-scale data acquired every cycle, and fine-scale data acquired every twentieth cycle, for a rate of 10 Hz.

The sensor configuration used for the Seamount Mixing cruise on the *R/V New Horizon* is shown below. (Pressure, temperature and conductivity do not have A/D channels assigned to them because they are acquired by the onboard CTD, which has its own A/D converter.)

fine sensors (10 Hz sampling)	**A/D channel**
pressure	–
temperature	–
conductivity	–
accelerometer top X	0
accelerometer top Y	1
accelerometer bottom X	2
accelerometer bottom Y	3
acoustic current meter X velocity	4
acoustic current meter Y velocity	5
X compass	6
Y compass	7
ground	14

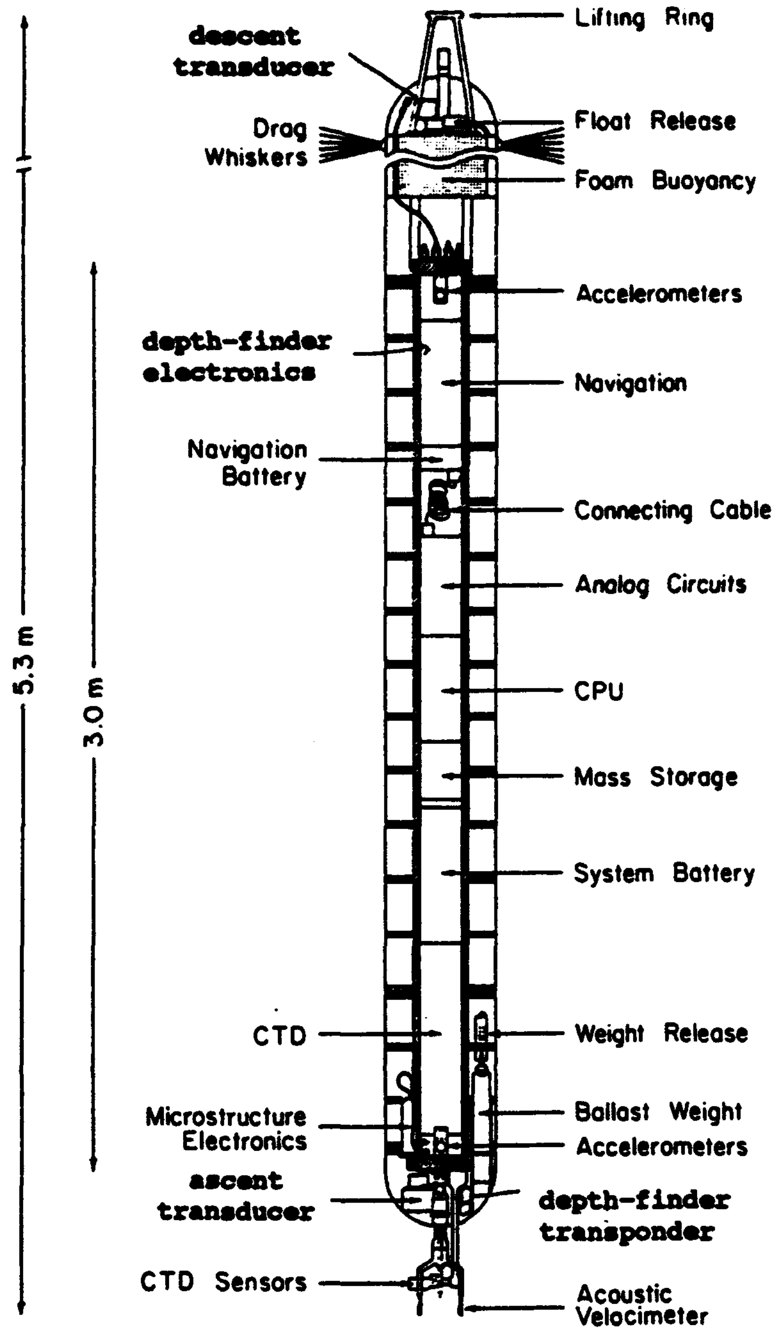

Figure 7: Cut-away section of the High Resolution Profiler (HRP).

micro sensors (200 Hz sampling)	A/D channel
micro conductivity	10
micro temperature	11
shear X	12
shear Y	13

Modifications to the HRP for the *New Horizon* cruise included the following: the addition of an acoustic bottom finder, moving the tracking transducer, improvement of the error recovery during data transfer, and implementation of the acoustic navigation system.

Since some of the processes of interest were expected to occur near the seamount's surface, the HRP needed to detect the bottom and have that information integrated into the dive control logic. To this end, a Datasonics model 900 bottom finder was purchased. Its electronics were mounted near the navigation system in the upper electronics rack of the HRP. The ranges detected are acquired as part of the fine-scale data stream, and are checked by the computer every 10 Hz cycle, as a condition for dive termination. With this addition, the HRP was able to terminate a dive based on the pressure, range or time threshold being passed, whichever came first.

Deep dives were planned for this cruise, meaning long data transfer times. Since the HRP cannot be deployed until all the data is removed from memory, the data transfer becomes a rate limiting step. Previously, if the transfer failed, the only recourse was to start again from the beginning. For this cruise, the data transfer programs were modified to allow the data transmission to be restarted from where it stopped. The first change was to "beep" the terminal to indicate the transfer had stopped. Additional changes display the last record transferred and query the user whether to restart and from which record.

Prior to the Seamount Mixing Cruise, the Navigation subsystem was never used. In pre-cruise tests, it was found not to function as expected, so modifications to the electronics and software were made to ensure that counts were accumulated correctly for each channel. The data acquired by the navigation system are useful only when a net of acoustic transponders is deployed on the seafloor. There were several profiles on this cruise for which a transponder net was deployed and meaningful navigation data were acquired.

Early in the cruise, spikes were observed in the velocity microstructure data. The tracking transducer's position in the nose of the HRP (near the micro sensors) was found to be the source of these spikes. Moving the transducer to the space between the pressure case and the floatation was found to eliminate the spikes from the data.

With the above improvements to the HRP, profiles were made to within ten meters of the seamount, no transducer induced spikes occurred in the microstructure data, the data transfer did not impede the progress of the cruise, and the navigation system worked successfully.

Data Processing

The HRP collects and stores fine-structure, microstructure, and navigation data. Each type is treated separately after it is removed from the HRP. The following section describes the data processing carried out routinely onboard the ship during a cruise.

The HRP is programmed to store one profile at a time in its memory. Consequently, after each deployment, the data must be offloaded to another computer for permanent storage. Serial data transfer at 34 kilobaud is used to move the data from HRP memory to the hard disk of a 386-PC. The transfer is first enabled at the HRP, then software on the PC controls the transfer. The data transfer rate allows the microstructure data for a 1000 meter profile to be sent to the PC in about 20 minutes. Once the data is transferred to the PC, the HRP can be programmed to start another dive. After several profiles of raw data have accumulated on the hard disk they are archived to optical disk. Additional information on the data transfer is provided in the report by Montgomery (1991).

Once the data is on the PC, it can be transferred to the post processing computer using FTP. The bulk of the data processing is accomplished on Digital Equipment Corporation VAX VMS computers using Fortran programs developed at WHOI. The first step is to convert the data into engineering units, and then store it in a binary format to conserve storage space (Millard and Galbraith 1982). Quality control time-series plots are then generated for each fine-structure and microstructure data channel. Sample quality control plots from profile 64 are shown in Figures 8a through 8d.

As the quality control plots are generated, a program to compute the fine scale temperature–salinity and velocity, profiles and bin the data in a uniformly incremented pressure series (typically 0.5 dbar) is run. The velocity computation scheme is described by Schmitt *et al.* (1988), and uses the acceleration and magnetometer data to correct the raw acoustic current meter data for instrument motion. Laboratory derived calibration data are used to convert raw pressure and temperature data to scientific units. A laboratory derived relationship is also utilized for the initial estimate of the conductivity cell calibration. Adjustments to this scaling are subsequently derived to obtain consistent deep water potential temperature–salinity relationships. The output is stored in another binary file from which a plot of temperature, salinity, east and north velocities versus pressure is created. An example of this type of plot, using profile 64, is shown in Figure 9.

Microstructure data processing is started concurrently with the fine, but takes much longer to complete due to its greater volume and the more intensive computations performed. The scheme used follows procedures developed by Neil Oakey (Bedford Institute of Oceanography). A report by Polzin and Montgomery (in prep.) describes the microstructure data processing, so only a brief summary is included here.

The processing utilizes laboratory derived calibration coefficients for the shear probes (microscale velocity sensors), while *in-situ* calibration data for the microscale temperature and conductivity sensors are obtained by reference to the fine-scale temperature and conductivity from the HRP's CTD. The microstructure data are binned in time blocks aligned with the uniformly incrementing pressure series of the reduced fine-scale data. Gradient variances are estimated in the

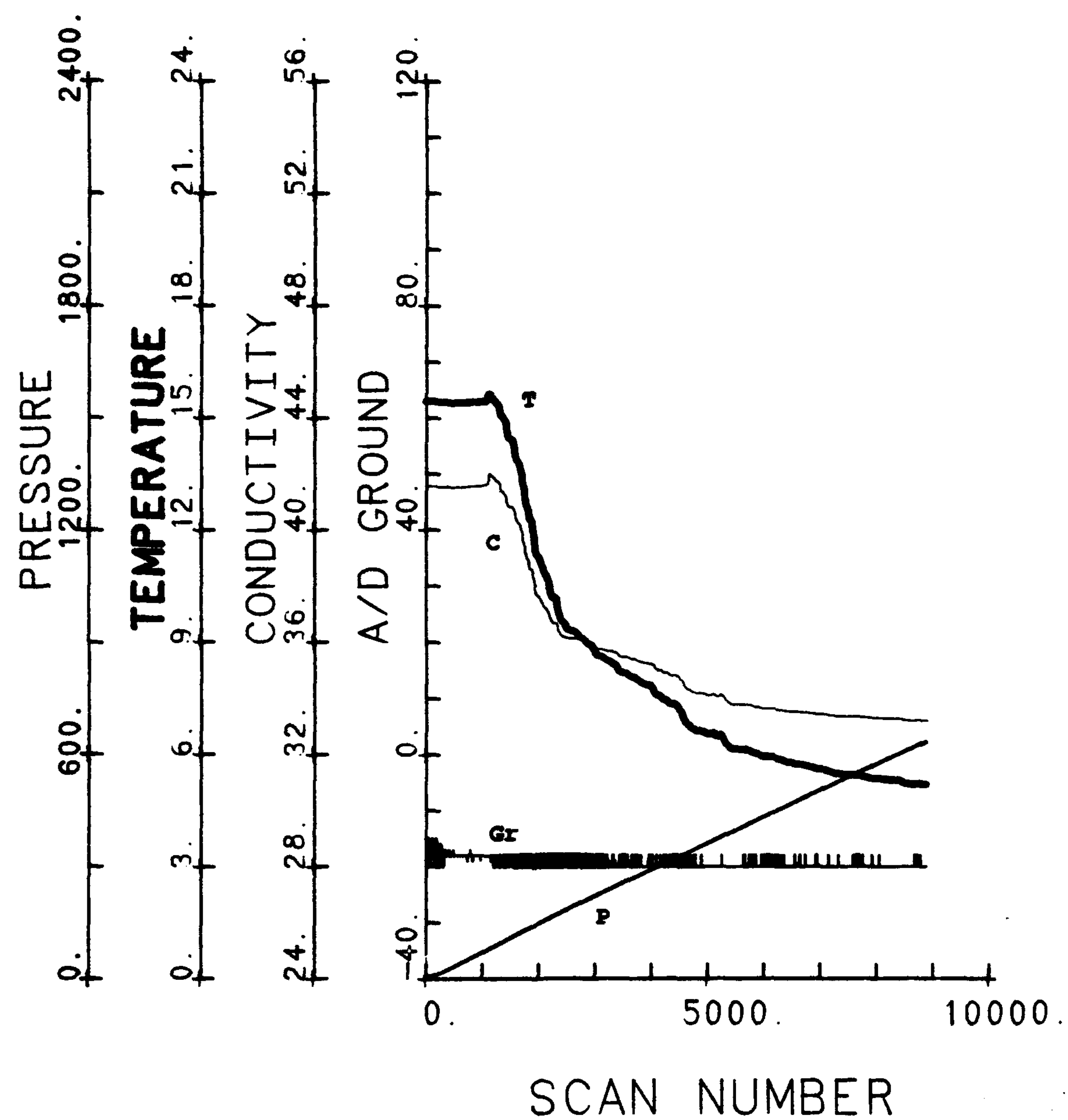

Figure 8a: Fine-scale quality control plot of pressure, temperature, conductivity and A/D ground plot versus scan number for dive 64.

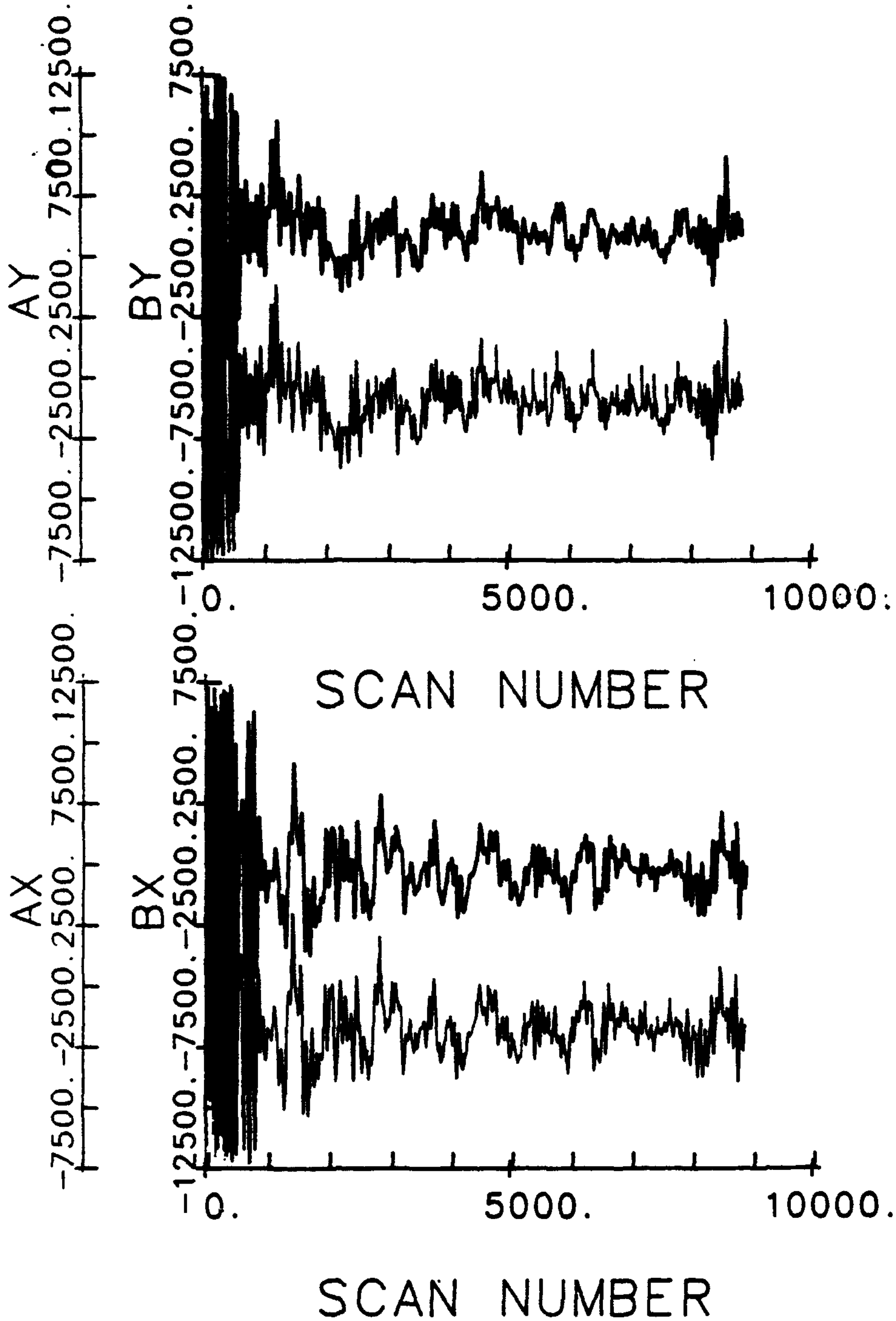

Figure 8b: Accelerometer data plotted versus scan number. The orthogonal sensor pair in the nose of the HRP is indicated by the thick line in both plots. The upper orthogonal sensor pair is shown by the thin trace.

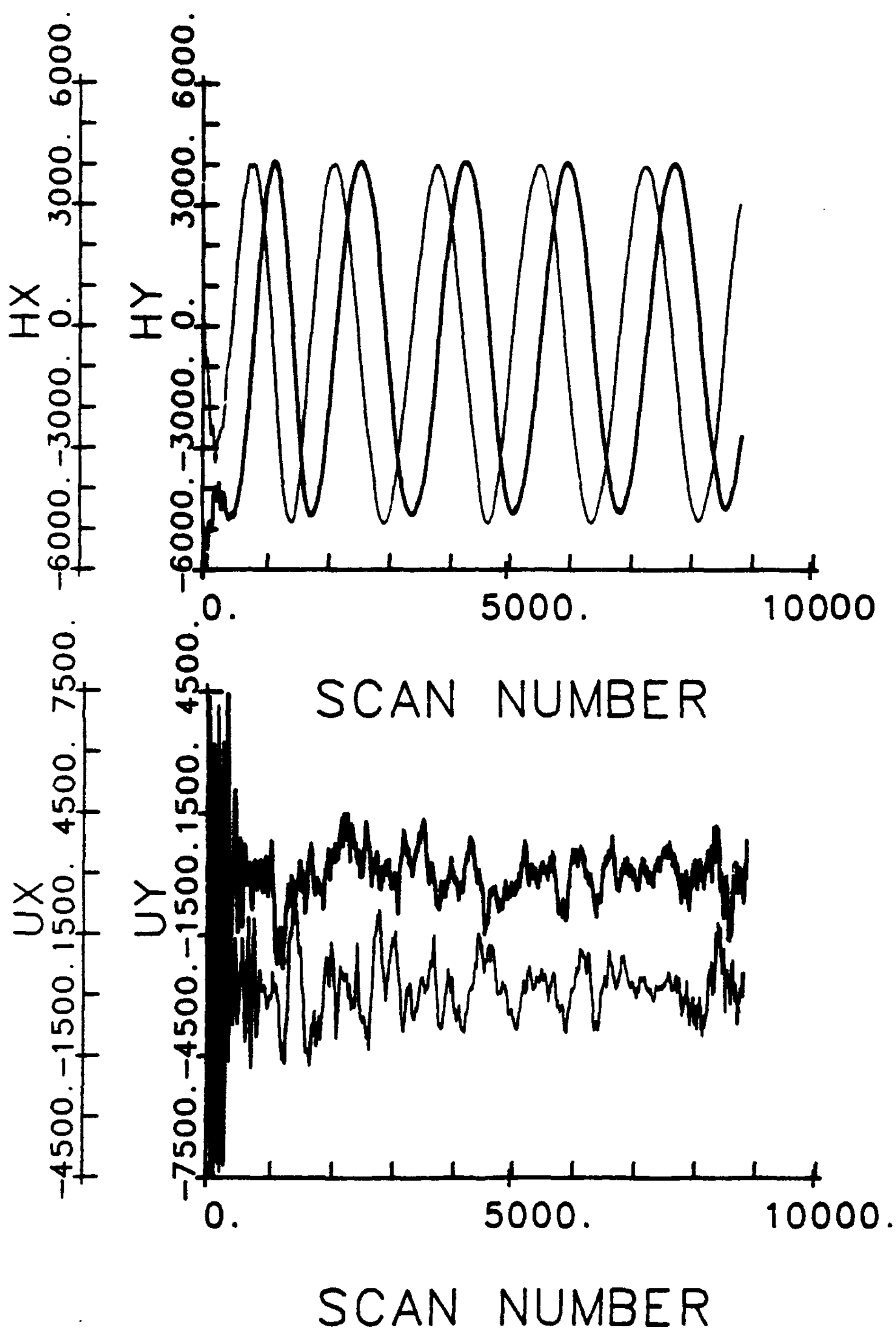

Figure 8c: Top plot: X (thin line) and Y (thick line) components of the compass versus scan number. The bottom plot shows the X (thin line) and Y (thick line) data from the acoustic velocimeter versus scan number.

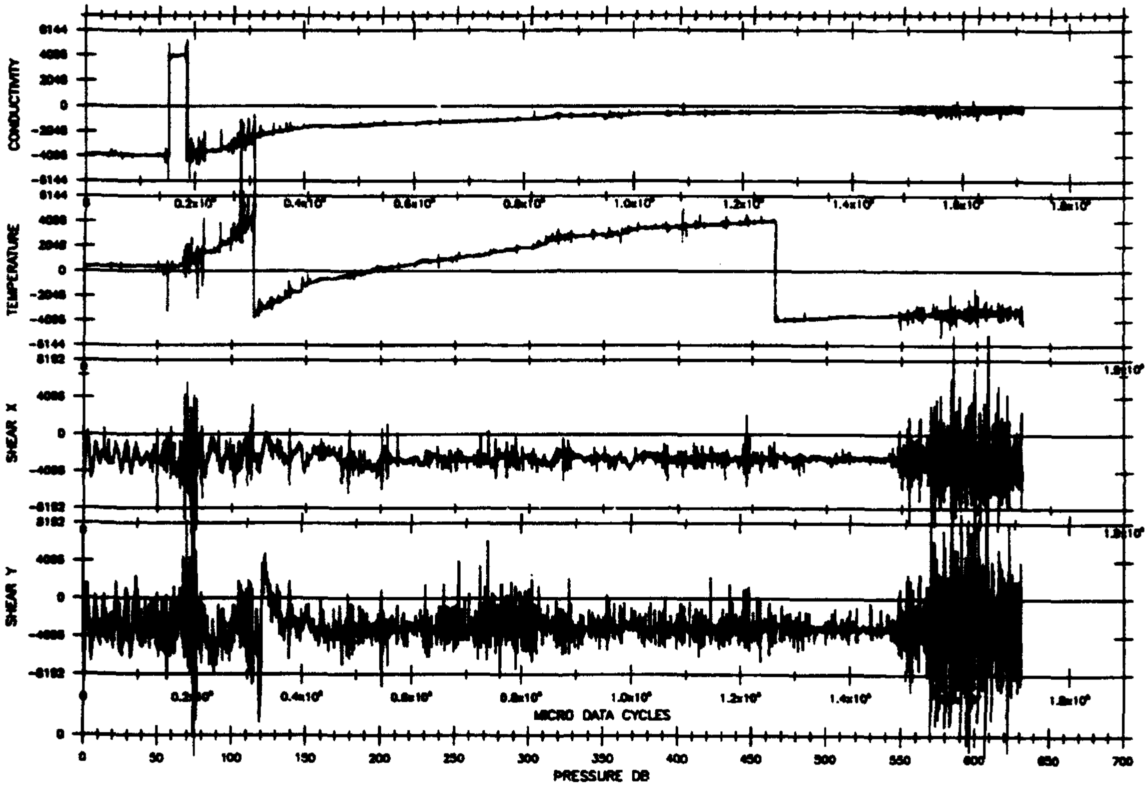

Figure 8d: Microstructure quality control plot for dive 64. Areas of high amplitude indicate possible turbulence.

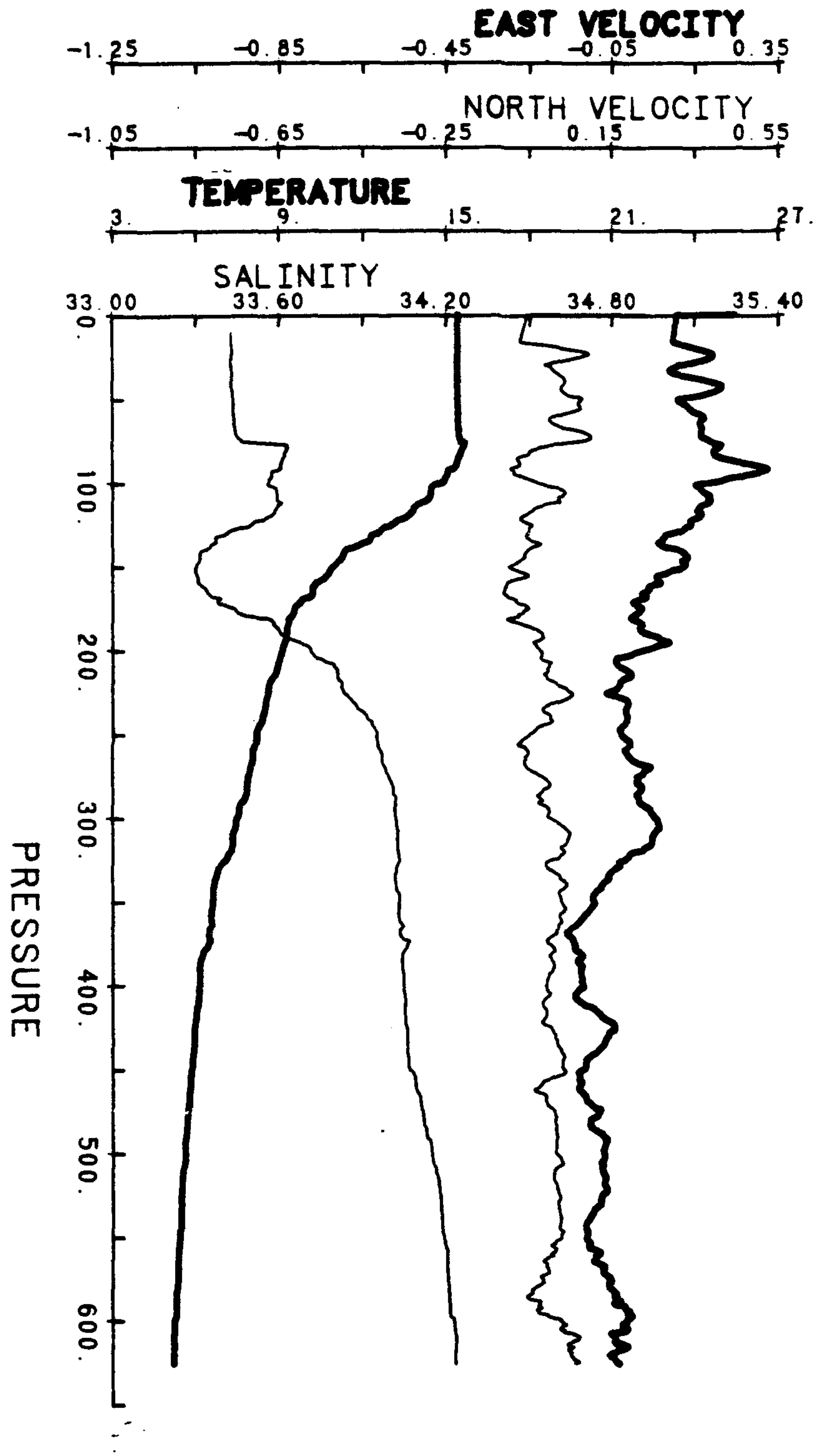

Figure 9: Computed velocity, temperature, and salinity plotted versus pressure for dive 64.

frequency domain after fast Fourier transforming by integrating spectra out to a local minima in energy density after spectral corrections are applied for the finite responses of the sensors. After automated edit and consistency checking, scaling to scientific units yields estimates of the kinetic energy dissipation rate (epsilon), and two measures of the dissipation rate of thermal variance (from the microscale temperature and conductivity sensors : Chi-T and Chi-C respectively). Profile plots (in "stick diagram" form) of the dissipation rates are then produced, examples of which (again using profile 64) are shown in Figures 10a, 10b, and 10c.

The navigation data are acquired only when a net of acoustic transponders is deployed on the seafloor. There were several profiles on this cruise for which a transponder net was deployed and the navigation data were obtained. For these profiles, a C program on the PC was executed to convert the raw counts to acoustic time in milliseconds to each transponder. These data could then be used to pinpoint where in the water column the HRP was, relative to the transponders, at any given time during its descent.

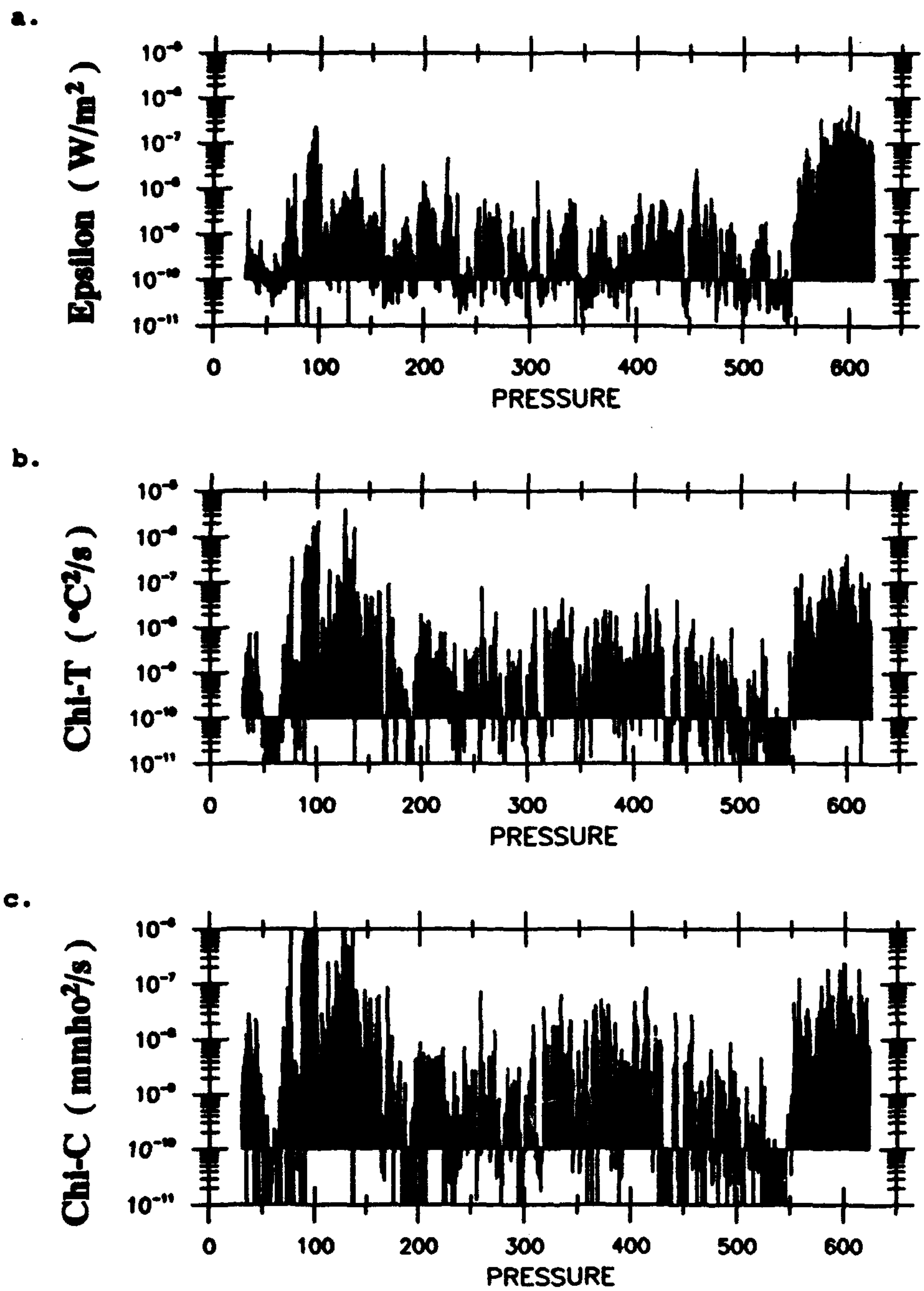

Figure 10: Plots of computed microstructure parameters, a) epsilon, b) Chi-T and c) Chi-C versus pressure for dive 64.

Summary

Overall, the *New Horizon* Seamount Mixing Cruise was very successful. All scientific objectives were met, no major instrument malfunctions occurred, and several mixing events were observed. Weather sometimes constrained the work schedule, but not excessively. HRP deployments and recoveries were regularly made in 20 to 25 knot winds, and up to 15 foot seas, 24 hours a day. When conditions were too rough for the HRP, XCP and XBT operations were conducted, minimizing dead time.

In 23 days spent at sea, 95 HRP profiles were completed on or near the seamount. Of these, 27 were associated with transects of the west or southeast flanks of the seamount. Another 16 profiles were done at the central C mooring site, and 17 were completed in time series at the F3 mooring site on the flank. A survey of the surrounding abyssal area consisting of 8 profiles to 3000 meters was also completed. The data from the deep (far field) profiles provide a measure of the background state for the area, which can be compared to observations near the seamount. The rest of the profiles were completed during surveys of the circumference of the seamount at 750 and 1500 meters. Eight additional HRP dives were completed in nearshore basins on the way back to port. Table 1 provides detailed information for each HRP profile taken during this cruise.

During the cruise, 120 XCP's were used to survey the velocity field over all but the southwest quadrant of the seamount. Some of the radial lines were repeated to provide data on temporal variation of the features observed. For data validation, XCP number 3297 and HRP dive 64 were done simultaneously.

The Serial ASCII Interface Loop (SAIL) system on the *R/V New Horizon* was upgraded just prior to the cruise. Despite the bugs in the new system, SAIL data were successfully acquired for 12 days. ADCP data were collected at the seamount, but not during the transits.

The data acquired during the *R/V New Horizon* cruise to Fieberling Guyot are summarized below, along with the person to contact for access to the data.

Summary of Data Acquired on the Seamount Mixing Cruise

Data Type	Number of Dives/Days	Custodian
HRP (T, S, velocity, micro-structure)	107	WHOI - Montgomery
XCP (T, velocity)	120	UW - Kunze
XBT (T)	144	UW - Kunze
ADCP (velocity)	24 days	WHOI - Montgomery
underway SAIL data	12 days	WHOI - Montgomery

Table 1: HRP Cast Positions: Seamount Mixing Cruise

March 1991

Abbreviation Key:

P = Pressure	T = Time	R = Range
NS = Near shore	SS = Seamount Summit	FM = F3 Mooring
TF= Top of Flank	CM = C mooring	DP = Deep Profiles
FS = Flank Survey	F2 = Fieberling II	SC = Santa Cruz
SM = Santa Monica	WT = Western Transect	ST = Southeast Transect

Cast #	Date/Time MO DA GMT	Latitude North	Longitude West	Water Depth	Pres Set	Pres Max	End By	Range Min.	Loc. Code
001	03 04 2045	32 35.470	117 28.200	1300	500	500.1	P	-	NS
002	03 04 2157	32 34.877	117 29.534	1205	1150	1150.3	P	-	NS
003	03 07 2140	32 26.480	127 43.520	535	505	473.9	R	75	SS
004	03 07 2258	32 26.411	127 43.390	535	505	481.9	R	75	SS
005	03 08 1326	32 27.150	127 46.330	520	490	488.2	R	40	WT
006	03 08 1446	32 27.103	127 48.443	555	540	540.1	P	27	WT
007	03 08 1700	32 27.068	127 50.443	742	730	730.1	P	-	WT
008	03 08 1849	32 27.114	127 51.471	1423	1380	1380.1	P	-	WT
009	03 08 2054	32 27.320	127 53.064	2391	2359	1034.7	T	-	WT
010	03 08 2338	32 27.320	127 56.110	3405	2500	2500.0	P	-	WT
011	03 09 0338	32 27.047	127 46.184	515	500	500.0	P	26	WT
012	03 09 0505	32 27.055	127 48.367	550	540	540.3	P	25	WT
013	03 09 0719	32 27.170	127 50.386	683	650	650.1	P	55	WT
014	03 09 0911	32 27.266	127 51.489	1433	1400	1400.0	P	110	WT
015	03 09 1105	32 27.007	127 52.873	2406	2350	2350.1	P	120	WT
016	03 09 1353	32 27.052	127 56.285	3440	2500	2500.1	P	-	WT
017	03 09 1830	32 24.735	127 50.174	1388	1350	1350.2	P	-	FM
018	03 09 2140	32 24.824	127 50.136	1482	1420	1460.1	P	-	FM
019	03 10 0040	32 24.648	127 50.037	1393	1370	1370.0	P	90	FM
020	03 10 0327	32 24.620	127 50.088	1457	1400	1400.1	P	155	FM
021	03 10 0633	32 24.673	127 50.086	1438	1430	1430.1	P	110	FM
022	03 10 0935	32 24.629	127 50.019	1433	1420	1420.0	P	95	FM
024	03 10 1533	32 24.746	127 50.038	1448	1430	1430.1	P	75	FM
025	03 10 1832	32 24.613	127 50.132	1448	1450	1450.1	P	-	FM
026	03 10 2149	32 25.426	127 49.422	693	675	659.7	R	50	TF
027	03 11 2100	32 26.660	127 46.235	505	490	490.2	P	20	CM
028	03 12 0009	32 26.594	127 46.136	505	500	492.9	R	20	CM

(Table 1 Continued)
HRP CAST POSITIONS

Cast #	Date/Time MO DA GMT	Latitude North	Longitude West	Water Depth	Pres Set	Pres Max	End By	Range Min.	Loc. Code
029	03 12 0302	32 26.731	127 46.101	497	500	478.5	R	17	CM
030	03 12 0601	32 26.458	127 46.175	497	500	489.4	R	16	CM
031	03 12 0858	32 26.507	127 46.108	500	500	499.4	R	15	CM
032	03 12 1202	32 26.612	127 46.136	505	500	499.9	R	15	CM
033	03 12 1500	32 26.658	127 46.140	505	505	500.9	R	12	CM
034	03 12 1800	32 26.573	127 46.113	505	505	501.7	R	10	CM
035	03 12 2[illegible]3	32 26.560	127 46.116	505	505	501.2	R	10	CM
036	03 13 0006	32 26.577	127 46.193	504	505	501.3	R	10	CM
037	03 13 0205	32 25.550	127 49.442	663	675	651.9	R	15	TF
038	03 13 0338	32 24.441	127 47.993	713	710	710.0	P	-	TF
039	03 13 0514	32 23.646	127 46.226	668	680	680.0	P	-	TF
040	03 13 0632	32 24.472	127 44.377	707	720	720.0	P	-	TF
041	03 13 0803	32 25.170	127 42.647	585	650	639.1	R	13	TF
042	03 13 0939	32 26.628	127 42.245	604	620	620.3	P	28	TF
043	03 13 1238	32 27.477	127 43.656	614	610	610.2	P	53	TF
044	03 13 1638	32 27.812	127 45.558	545	540	540.1	P	53	TF
045	03 13 1757	32 28.799	127 47.293	668	660	448.7	T	-	TF
046	03 13 1930	32 28.464	127 49.210	712	710	710.1	P	-	TF
047	03 13 2054	32 26.943	127 50.430	745	740	740.4	P	-	TF
048	03 13 2223	32 25.366	127 49.470	742	740	740.4	P	-	TF
049	03 16 0401	32 26.688	127 46.168	501	495	495.4	P	19	WT
050	03 16 0557	32 27.030	127 50.306	675	700	673.1	R	20	WT
051	03 16 0727	32 27.027	127 51.429	1383	1350	1350.2	P	100	WT
052	03 16 0920	32 27.022	127 52.824	2376	2380	2380.0	P	65	WT
053	03 16 1237	32 27.053	127 56.022	3359	2500	2500.1	P	-	WT
054	03 16 1606	32 26.583	127 46.139	505	505	503.8	R	10	ST
055	03 16 1732	32 25.160	127 42.628	604	604	604.2	P	30	ST
056	03 16 1849	32 24.729	127 41.741	1408	1412	1412.0	P	80	ST
057	03 16 2300	32 24.279	127 41.182	1879	1880	1880.1	P	25	ST
058	03 17 1512	32 23.780	127 39.861	2386	2385	2385.0	P	75	ST
059	03 17 1812	32 23.150	127 38.200	3500	2500	2500.0	P	-	ST
060	03 17 2130	32 26.678	127 46.204	507	506	505.1	R	10	ST
061	03 17 2302	32 25.211	127 42.552	742	740	740.1	P	15	ST
062	03 18 0026	32 24.680	127 41.784	1344	1360	1360.0	P	-	ST
063	03 18 0225	32 25.188	127 42.532	740	745	745.1	P	29	ST
064	03 18 0411	32 25.196	127 42.615	595	700	632.6	R	12	ST
065	03 18 0919	32 24.303	127 41.074	1864	1860	1860.0	P	-	ST
066	03 18 1142	32 23.939	127 40.175	2317	2300	2300.2	P	45	ST
067	03 18 1434	32 23.067	127 38.190	3500	2500	2500.2	P	-	ST
068	03 18 1851	32 27.011	127 22.618	4000+	3000	2974.9	T	-	DP

Table 1 (Continued)
HRP CAST POSITIONS

Cast #	Date/Time MO DA GMT	Latitude North	Longitude West	Water Depth	Pres Set	Pres Max	End By	Range Min.	Loc. Code
069	03 18 2242	32 26.979	127 34.495	4000+	3000	3000.3	P	–	DP
070	03 19 0457	32 46.991	127 46.166	4500+	3000	3000.1	P	–	DP
071	03 19 1454	32 37.146	127 46.186	4000+	3000	3000.2	P	–	DP
072	03 21 1800	32 26.983	128 08.302	4000+	3000	3000.1	P	–	DP
073	03 21 2212	32 27.110	127 56.057	3500+	3000	3000.3	P	–	DP
074	03 22 0349	32 06.959	127 46.258	4300+	3000	3000.0	P	–	DP
075	03 22 0742	32 16.953	127 46.160	3375	3000	3000.1	P	–	DP
076	03 22 1153	32 26.615	127 46.167	500	494	494.1	P	20	CM
077	03 22 1331	32 24.350	127 49.879	1482	1520	1520.2	P	135	FM
078	03 22 1630	32 24.683	127 50.114	1512	1600	1591.0	T	0	FM
079	03 22 2250	32 24.718	127 50.073	1433	1400	1400.1	P	120	FM
080	03 23 0134	32 24.721	127 50.121	1403	1425	1425.2	P	120	FM
081	03 23 0520	32 24.672	127 50.107	1383	1370	1370.0	P	150	FM
082	03 23 0805	32 24.800	127 49.993	1341	1340	1340.2	P	80	FM
083	03 23 1107	32 24.747	127 50.027	1373	1370	1370.0	P	95	FM
084	03 23 1404	32 24.700	127 50.018	1383	1383	1383.1	P	75	FM
085	03 23 1633	32 25.362	127 49.505	718	718	718.2	P	–	FS
086	03 23 1706	32 26.533	127 46.064	496	496	495.8	R	15	FS
087	03 23 1934	32 23.598	127 46.184	653	653	653.2	P	76	FS
088	03 23 2059	32 21.824	127 46.251	1265	1265	1265.1	P	128	FS
089	03 23 2303	32 25.213	127 42.520	643	643	643.2	P	–	FS
090	03 24 0057	32 24.543	127 41.693	1383	1390	1390.0	P	–	FS
091	03 24 0310	32 27.360	127 43.422	591	585	585.1	P	29	FS
092	03 24 0427	32 28.812	127 43.578	1665	1650	1650.2	P	125	FS
093	03 24 0632	32 28.794	127 47.328	673	660	660.4	P	23	FS
094	03 24 0746	32 30.021	127 46.938	1359	1320	1320.1	P	220	FS
095	03 24 0958	32 26.912	127 50.341	658	650	650.3	P	90	FS
096	03 24 1159	32 27.033	127 52.845	2227	2000	2000.0	P	–	FS
097	03 24 1428	32 26.535	127 46.061	505	505	502.4	R	12	CM
098	03 24 1808	32 16.048	127 14.891	1023	1023	1023.4	P	50	F2
099	03 24 2102	32 15.490	127 14.309	1235	1235	1129.8	T	–	F2
100	03 27 0236	33 41.288	119 33.353	1904	1700	1700.0	P	225	SC
101	03 27 0601	33 41.356	119 33.292	1904	1850	1850.4	P	-	SC
102	03 27 0933	33 41.390	119 33.416	1904	1850	1850.1	P	50	SC
103	03 27 1305	33 41.256	119 33.449	1899	1850	1859.0	P	50	SC
104	03 27 1905	33 45.025	118 54.985	895	880	880.0	P	27	SM
105	03 27 2234	33 44.984	118 54.869	895	885	885.2	P	29	SM
106	03 28 0158	33 45.019	118 55.055	895	885	885.1	P	25	SM
107	03 28 0531	33 44.954	118 55.007	895	885	885.1	P	23	SM

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References

Mellinger, E. C., K. E. Prada, R. L. Koehler, and K. W. Doherty, 1986. Instrument Bus: An Electronic System Architecture for Oceanographic Instrumentation. Woods Hole Oceanographic Institution Technical Report WHOI-86-30, 86 pp.

Millard, R. C., and N. Galbraith, 1982. WHOI Processed CTD Data Organization. Woods Hole Oceanographic Institution Technical Report WHOI-82-37, 42 pp.

Montgomery, E. T., 1991. The High Resolution Profiler (HRP) User's Guide and Software Modification Documentation. Woods Hole Oceanographic Institution Technical Report WHOI-91-01, 32 pp.

Polzin, K., and E. T. Montgomery. Microstructure Data Processing Methods for Use with High Resolution Profiler (HRP) Data. Woods Hole Oceanographic Institution Technical Report (in preparation).

Schmitt, R.W., J.M. Toole, R.L. Koehler, and K.W. Doherty, 1988. The Development of a Fine- and Micro-structure Profiler. *Journal of Atmospheric and Oceanic Technology*, 5, 484–500.

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16. Abstract (Limit: 200 words)

This report describes fine– and microstructure profile data taken on a cruise to Fieberling Guyot, a seamount in the northeast subtropical Pacific Ocean. The work performed at sea, instruments used, data return and processing procedures will be summarized here. This cruise took place between March 4 and March 28, 1991 on the R/V *New Horizon*, and was part of the interdisciplinary Accelerated Research Initiative (ARI) for Abrupt Topography sponsored by the Office of Naval Research. An overall goal of the ARI was to understand the physical, biological, and geological processes occurring near a seamount.

The scientific objective of the Seamount Mixing Cruise was to collect data describing the oceanic fine-scale velocity and density fields, as well as the related turbulence and mixing in the vicinity of the seamount. The High Resolution Profiler (HRP) was deployed 95 times above and around the seamount. As well, two test dives were conducted on the way to the site, and eight deployments completed in deep basdins off the southern California coast before returning to port. Three near-synoptic surveys of the seamount were completed with the deployment of 128 Expendable Current Profilers (XCP's). The temperature field of the upper 760 meters of water within a 50 kilometer radius of the seamount was mapped using 144 Expendable Bathythermographs (XBT's).

17. Document Analysis a. Descriptors

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turbulence, diffusion & mixing processes

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