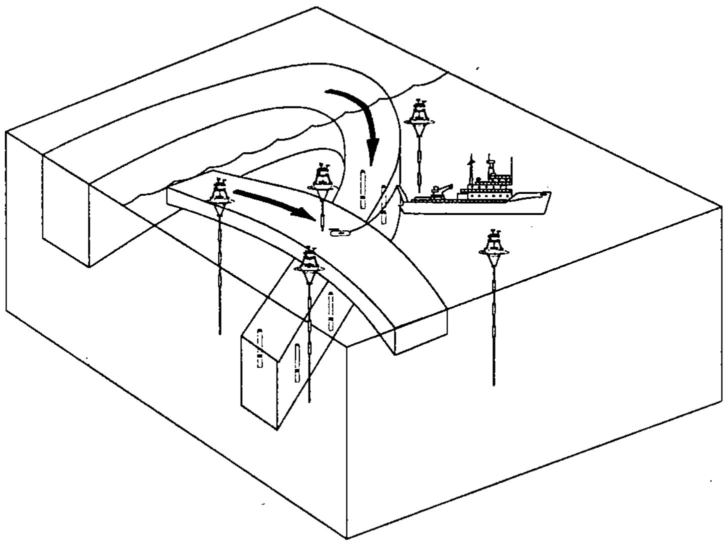
Woods Hole Oceanographic Institution **WHOI-93-13**

C.2

Technical Report
March 1993

The Subduction Experiment



Cruise Report
R/V *Oceanus*
Cruise Number 250 Legs 1 and 2
Subduction 2 Mooring Deployment and Recovery Cruise
25 January – 26 February 1992

by

Richard P. Trask
Nancy J. Brink
Lloyd Regier
Neil McPhee

Upper Ocean Processes Group
UOP Technical Report 93-2

WHOI-93-13
UOP Report 93-2

The Subduction Experiment
Cruise Report
R/V Oceanus
Cruise Number 250 Legs 1 and 2
Subduction 2 Mooring Deployment and Recovery Cruise
25 January – 26 February 1992

by

Richard P. Trask

Nancy J. Brink

Lloyd Regier

Neil McPhee

Upper Ocean Processes Group
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

March 1993

Technical Report

Funding was provided by the Office of Naval Research under contract N00014-90-J-1490.

Approved for Distribution:

James Luyten, Chair
Department of Physical Oceanography

Abstract

Subduction is the mechanism by which water masses formed in the mixed layer and near the surface of the ocean find their way into the upper thermocline. The subduction process and its underlying mechanisms were studied through a combination of Eulerian and Langrangian measurements of velocity, measurements of tracer distributions and hydrographic properties and modeling.

An array of five surface moorings carrying meteorological and oceanographic instrumentation were deployed for a period of two years beginning in June 1991 as part of an Office of Naval Research (ONR) funded Subduction experiment. Three eight month deployments were planned. The moorings were deployed at 18°N 34°W, 18°N 22°W, 25.5°N 29°W, 33°N 22°W and 33°N 34°W.

A Vector Averaging Wind Recorder (VAWR) and an Improved Meteorological Recorder (IMET) collected wind speed and wind direction, sea surface temperature, air temperature, short wave radiation, barometric pressure and relative humidity. The IMET also measured precipitation. The moorings were heavily instrumented below the surface with Vector Measuring Current Meters (VMCM) and single point temperature recorders.

Expendable bathythermograph (XBT) data were collected and meteorological observations were made while transitting between mooring locations.

This report describes the work that took place during R/V Oceanus cruise number 250 which was the second scheduled Subduction mooring cruise. During this cruise the first setting of the moorings were recovered and redeployed for a second eight month period. This report includes a description of the instrumentation that was deployed and recovered, has information about the underway measurements (XBT and meteorological observations) that were made including plots of the data and presents a chronology of the cruise events.

Table of Contents

List of Figures

List of Figures (Continued)

List of Tables

Section 1: Introduction

R/V Oceanus cruise number 250, Leg 1 departed Woods Hole, Massachusetts, on 25 January 1992 to recover and redeploy five surface moorings as part of the Office of Naval Research (ONR) funded ASTEX and Subduction Experiments. This cruise involved personnel and equipment from both the Woods Hole Oceanographic Institution (WHOI) and Scripps Institution of Oceanography (SIO). Appendix 1 lists the cruise participants.

The first setting of Subduction moorings were deployed in June/July 1991 during Oceanus cruise number 240 (see Trask and Brink, 1993 for details). The first setting has been referred to as Subduction 1. The Subduction 1 moorings were recovered and replaced with 5 new surface moorings during Oceanus cruise 250. The deployment schedule for the entire experiment is shown below (figure 1). Table 1 lists the Subduction 1 mooring positions and the dates they were deployed and recovered. Table 2 lists the deployment positions and dates for the second setting (aka Subduction 2). In addition to the initial deployment and first turnaround cruise a second turnaround cruise in October 92 and the final recovery cruise in June 93 are shown.

This report has in addition to this introduction two other sections. The second section describes the mooring program including the instrumentation that was deployed and recovered, as well as the underway measurements that were made including the XBT and meteorological observations. The third section is a chronology of the entire cruise.

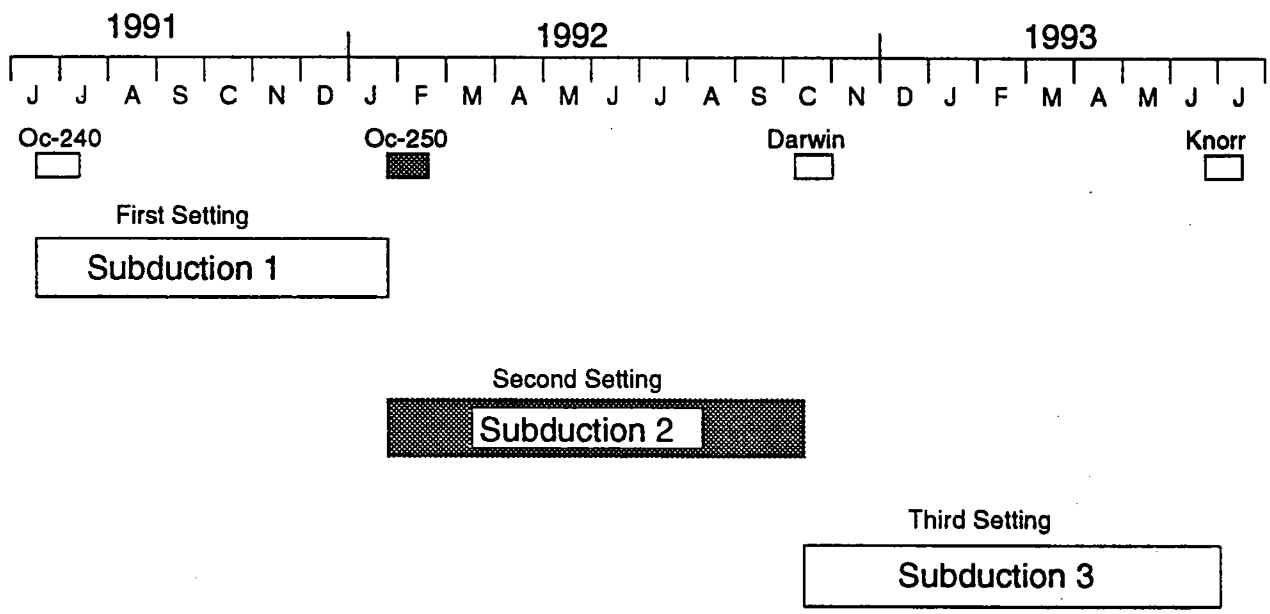


Figure 1. Mooring and Cruise Schedule

Table 1. Subduction 1
Mooring Deployment and Recovery Information

Buoy	Mooring #	Deployment Time (UTC)	Recovery Time (UTC)	Position (GPS)
NE	914	18 Jun1991 1642	14 Feb 1992 2315	33° 00.07'N 21° 59.75'W
C	915	23 Jun 1991 0026	11 Feb 1992 1120	25° 31.90'N 28° 57.17'W
SW	916	25 Jun 1991 1312	2 Feb 1992 0727 4 Feb 1992 1844 *	18° 00.03'N 33° 59.96'W
SE	917	29 Jun 1991 0137	30 Oct 1991 0000 8 Feb 1992 0843**	18° 00.13'N 22° 00.00'W
NW	918	3 Jul 1991 1323	15 Sept 1991 2035 23 Feb 1992 1022***	32° 54.61'N 33° 53.50'W

* SW Mooring broke free on 3 November 1991. Top 110m recovered 2 February 1992 remainder of mooring recovered 4 February 1992.

** SE Mooring broke free on 10 October 1991. Top 50m recovered on 30 October 1991 remainder of mooring recovered 8 February 1992

*** NW Mooring broke free on 3 August 1991. Top 400m recovered 15 September 1991 remainder of mooring recovered 23 February 1992

Table 2. Subduction 2
Mooring Deployment Information

Buoy	Mooring Number	Deployment Time (UTC)	Position (GPS)
SW	924	05 Feb 1992 1318	17°59.93'N 34°00.65'W
SE	925	09 Feb 1992 0244	17°59.72'W 22°00.29'W
C	926	12 Feb 1992 1915	25°31.95'N 28°57.23'W
NE	927	20 Feb 1992 1547	33°01.98'N 22°00.27'W
NW	928	23 Feb 1992 2328	32°54.42'N 33°53.35'W

Section 2: The Mooring Program

A. Moorings and Buoys

The goal of the mooring program conducted during Oceanus cruise number 250 (Oc-250) was to recover five moorings that were deployed during Oceanus cruise 240 leg 3 in June/July of 1991, and deploy replacement moorings. The five surface moorings deployed in 1991 included two WHOI discus buoy moorings designated the Northeast and Central moorings and three SIO toroid buoy moorings designated Southwest, Southeast and Northwest. The names of the moorings denote their relative placement in the moored array. Figure 2 shows the location of the individual moorings.

In August 1991 the Northwest mooring parted and the toroid buoy and upper mooring components went adrift. The drifting buoy was subsequently recovered on 15 September during R/V Endeavor cruise number 228. Failure of the Southeast mooring occurred on 10 October 1991. The toroid buoy from this mooring was recovered by the Soviet Research Vessel Mendeleev on 30 October 1991. This was followed by the failure of the Southwest surface mooring which occurred on 3 November 1991. The first stop of Oceanus cruise 250 was to recover the toroid buoy from the Southwest mooring which had drifted 642 miles to the southwest. Appendix 2 describes the SIO mooring designs for Subduction 1 and details the improvements made for Subduction 2.

Since all three of the SIO moorings had failed during the first setting, major design changes were made before the second setting. In addition, the complement of surface buoys was changed such that four of the five moorings deployed during Oc-250 had a WHOI 10' diameter discus buoy as their primary flotation at the surface. The fifth mooring had a SIO 7'6" diameter toroid buoy (from the first setting) for its surface flotation. Additional buoyancy was provided to the toroid by means of a large boat fender that was inserted in the center hole of the toroid and inflated. Figure 3 schematically shows the five Subduction 1 moorings and the distribution of the subsurface instrumentation. Figure 4 shows the five Subduction 2 moorings and their distribution of instrumentation.

Meteorological instrumentation was mounted to both the toroid and discus buoys. A two part aluminum tower was attached to both buoy types. The top half, which had the meteorological sensors, marine lantern and satellite antennae was the same for both buoy types so as to minimize the differences between buoys and to facilitate assembly. The lower half was specific to the buoy type and acted as an interface between the buoy hull and the tower top. The tower tops were separate assemblies so that they could easily be replaced with new units containing freshly calibrated sensors when the moorings were recovered and redeployed.

The two additional discus buoys and one toroid buoy deployed during Oc-250 were prepared in Woods Hole and loaded on Oceanus. These buoys serviced the first three moorings encountered. The toroid was used for the Southwest mooring and the discus' were used on the Southeast and Central moorings. The Central and Northeast discus' deployed in 1991 which were still on station were recovered and taken into Madeira where they were serviced and made ready for use on the Northeast and Northwest moorings. A port stop in Madeira was necessary because the ship could not carry all the equipment for the entire cruise due to deck space and weight limitations. Previous arrangements had been made to ship the equipment needed for the rest of the cruise to Madeira so that it was there when the Oceanus arrived.

Figure 2. Oceanus 250 ship track and mooring locations.

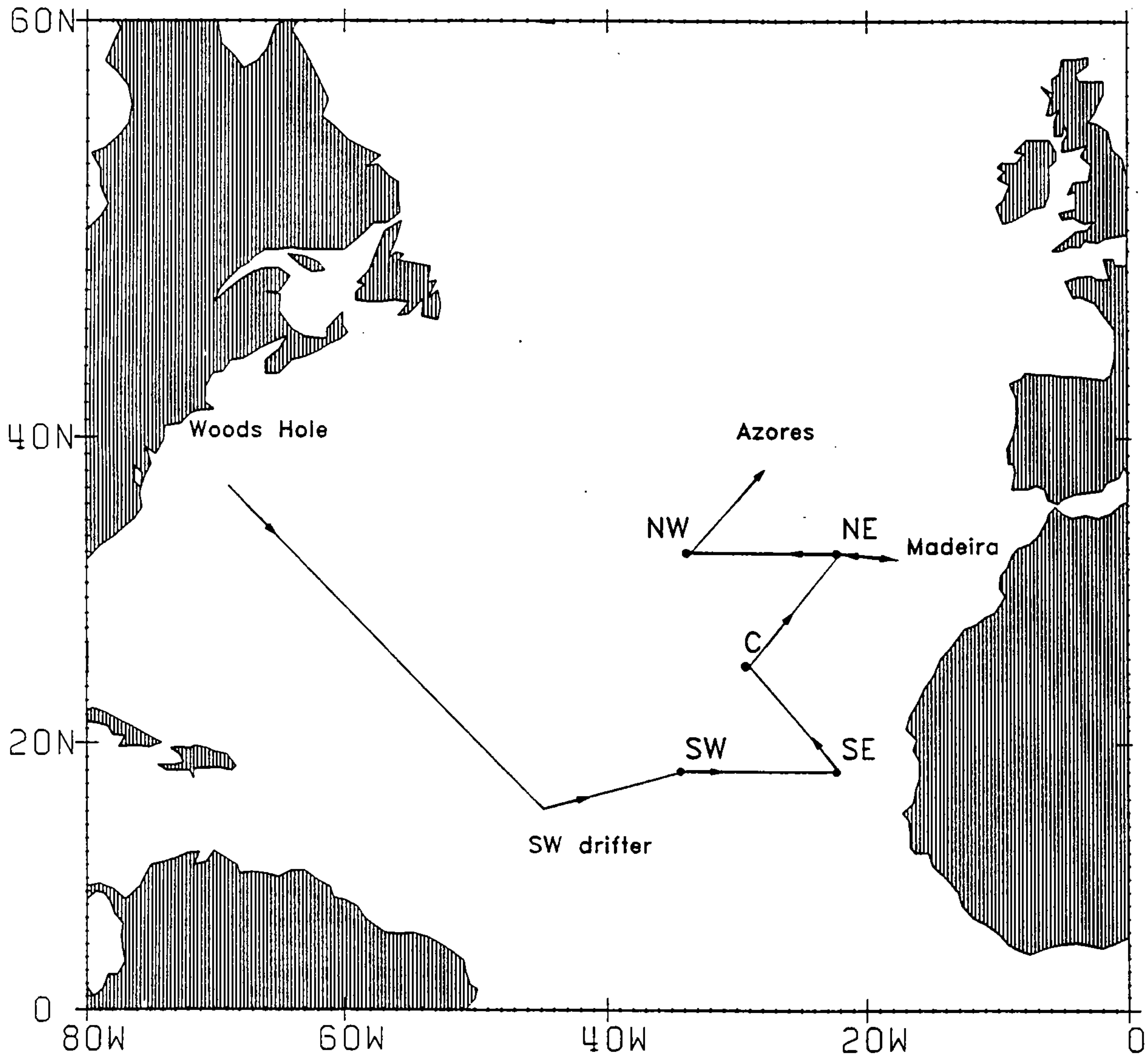


Figure 3. Instrument Positions on the Subduction 1 Moorings

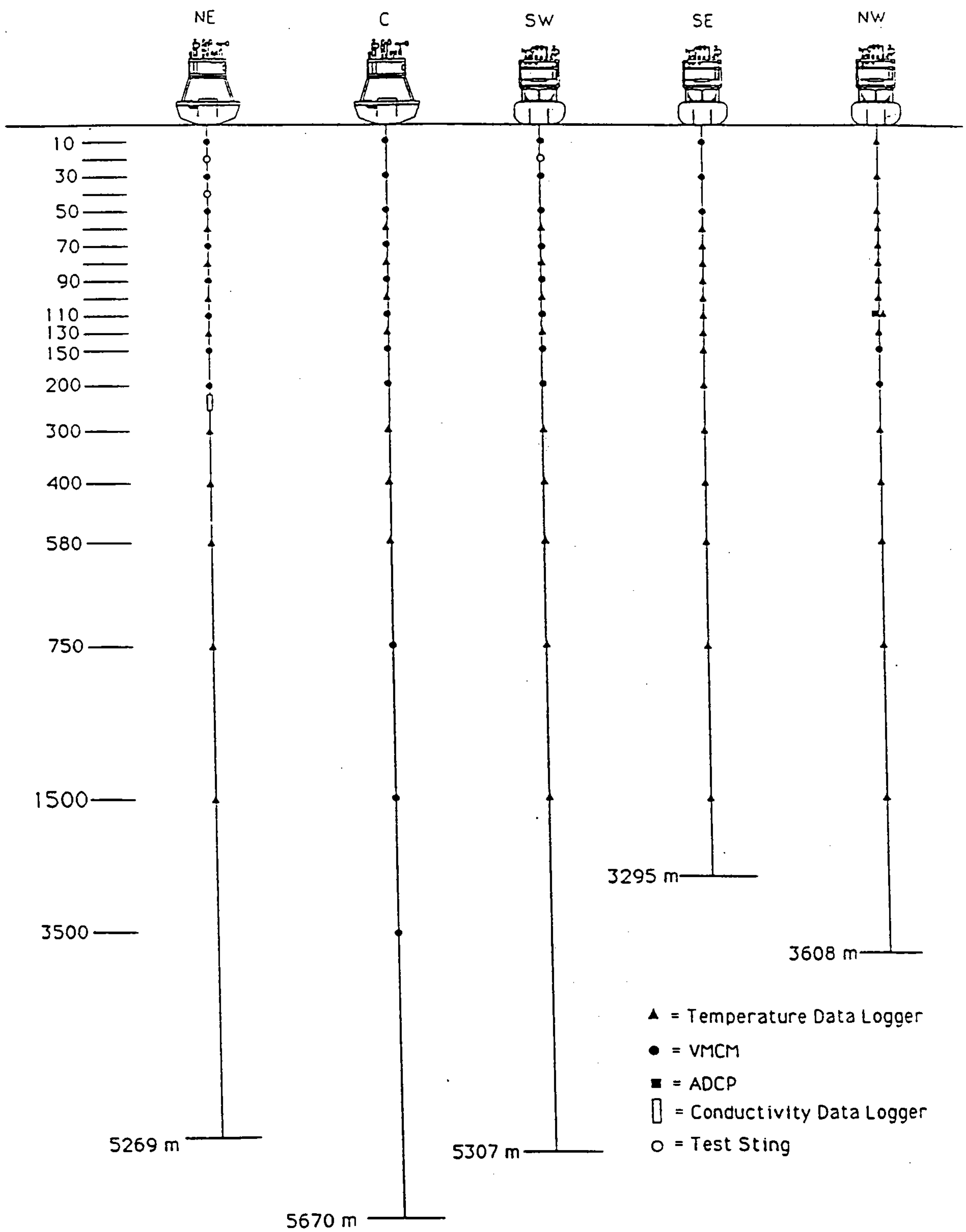
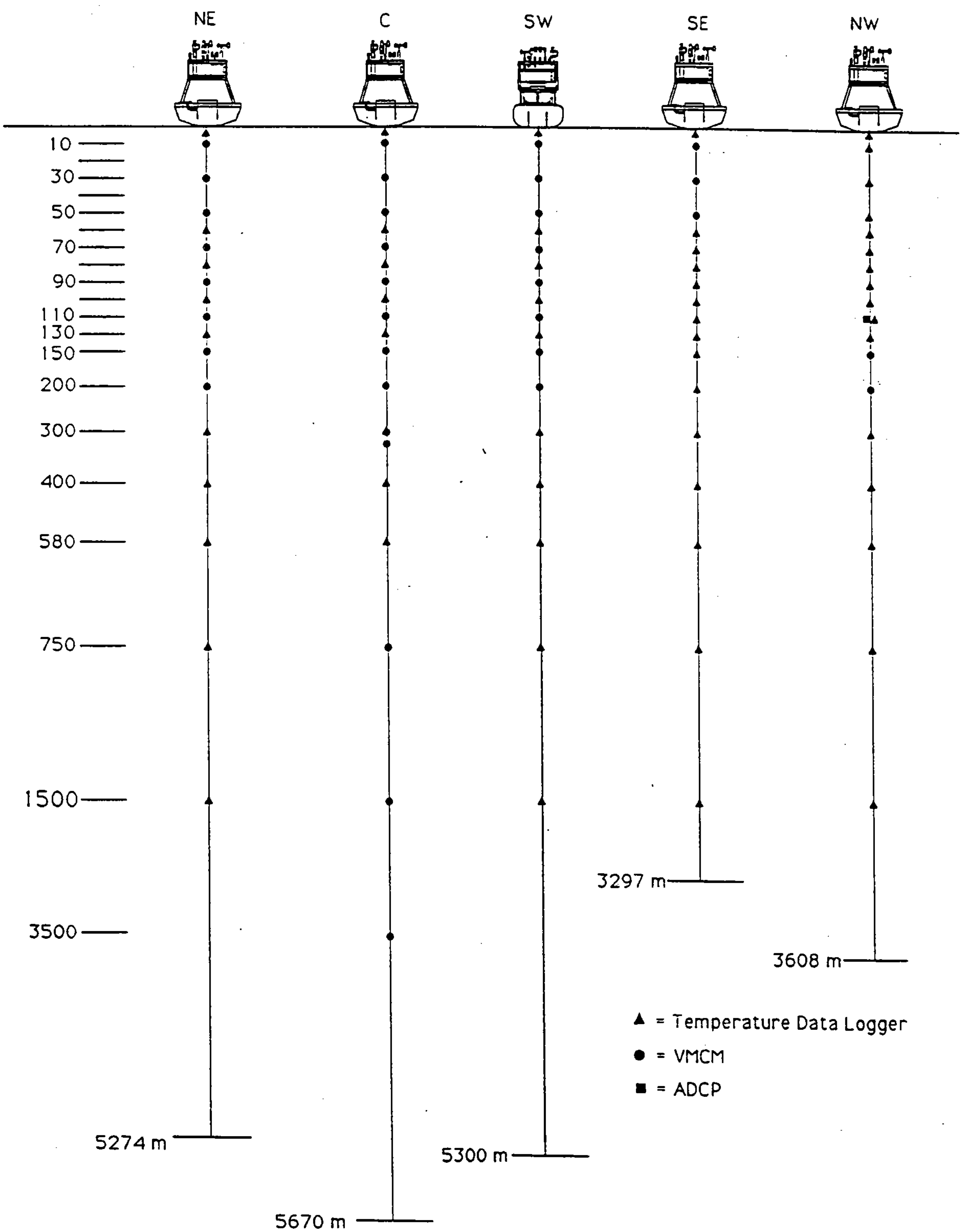


Figure 4. Instrument Positions on the Subduction 2 Moorings



B. Instrumentation

A total of 102 recording instruments were deployed on the five Subduction 2 moorings. There were 9 meteorological packages, 34 current meters, 58 temperature data loggers, and one Acoustic Doppler Current Profiler. The specific instrumentation deployed and recovered from the first Subduction setting is shown in table 3. The instrumentation on the second setting is shown in table 4.

Meteorological Instrumentation

Each discus buoy was outfitted with two separate meteorological instruments. One system was a Vector Averaging Wind Recorder (VAWR) which recorded measurements of wind speed and direction, air temperature, relative humidity, barometric pressure, sea surface temperature, shortwave radiation, and longwave radiation. Additional information about the VAWR can be found in Trask et al., (1989). The other meteorological package was an IMET system which made measurements of the same variables as the VAWR plus precipitation. The IMET systems on the second Subduction deployment did not have longwave radiation sensors. Both the VAWR and IMET systems individually recorded all data internally as well as telemetered their data via Argos. The VAWR stored its data on cassette tape every 15 minutes and the IMET system recorded on optical disk every minute.

For both the discus and toroid buoys the VAWR sensors (except sea temperature) and electronics with battery pack were attached to the tower top. The sea surface temperature sensors for both the VAWR and IMET systems were attached to the buoy bridle approximately 1 meter below the surface. All other meteorological sensors were placed at the same heights on the tower tops as in Subduction 1 (see Trask and Brink, 1993). During the second Subduction setting the Southwest toroid did not have an IMET system. The IMET sensors on all the discus buoys were configured the same and mounted on the tower top. The IMET electronics and rechargeable batteries were housed in the discus buoy water tight instrument well.

Details regarding the IMET performance during the first setting can be found in Appendix 3.

Prior to deployment the air and sea temperature sensors as well as the relative humidity sensors were calibrated at WHOI. The calibrations of the barometric pressure sensors were checked and if found out of specification were returned to the manufacturer for recalibration. The shortwave and longwave radiation sensors were calibrated by the manufacturer. The wind direction sensor readings were compared with a known bearing to a fixed target. Details of the direction comparison tests can be found in Appendix 4.

Current Meters

A total of 34 Vector Measuring Current Meters (VMCM) provided by both WHOI and SIO were deployed on the five Subduction 2 surface moorings. The 22 WHOI VMCMs were a modified version of the EG&G Sea Link instrument whereas the 12 SIO VMCMs were built by Scripps personnel. The sampling interval of the WHOI VMCMs was 7.5 minutes, and for the SIO VMCMs it was 15 minutes.

The WHOI VMCMs incorporated several changes to the standard EG&G Sea Link product. These included different propeller bearings, a different plastic for the propeller blades, an external temperature pod for faster temperature response, and a redesigned the instrument cage. The cage redesign and external temperature pod is described in Trask et al., (1989) as is some historical information on propeller bearings and blade materials.

Table 3.
Subduction 1 Instrumentation

Depth	NE	C	SW	SE	NW
VAWR IMET	V-704WR	V-722WR	V-720WR	V-721WR	V-121WR
10	VM-041	VM-035	SVM-04	SVM-12	S-3285
20	TEST STING1			TEST STING2	
30	VM-021	VM-033	SVM-07	VM-007	S-3315
40	TEST STING3				
50	VM-039	VM-024	SVM-06	SVM-16	S-3294
60	W-3274	W-3309	S-3314	W-3297	W-3262
70	VM-032	VM-012	SVM-22	S-3282	S-3313
80	W-3265	W-3308	W-3279	S-3270	S-3260
90	VM-022	VM-038	SVM-02	S-3298	S-3261
100	W-3288	W-3296	W-3303	S-3284	W-3258
110	VM-030	VM-009	SVM-05	S-2425	ADCP S-3277
130	W-3269	W-3280	S-2427	S-2432	S-2434
150	VM-028	VM-037	SVM-20	S-2418	SVM-11
200	VM-018	VM-016	SVM-13	S-2424	SVM-10
206	COND				
300	W-3300	W-3289	S-2435	S-2433	S-2421
400	W-3305	W-3283	S-2437	S-2422	S-2431
580	W-3268	W-3271	W-3341	W-3290	W-3272
750	W-3286	VM-015	S-2436	S-2426	S-2420
1500	W-3293	VM-034	W-3287	W-3259	W-3273
3490		TENS 1029			
3500		VM-011			

W-# = WHOI Brancker Temperature Recorder
S-#= SIO Brancker Temperature Recorder
VM-# = WHOI Vector Measuring Current Meter
SVM-#= SIO Vector Measuring Current Meter

Table 4.
Subduction 2 Instrumentation

Depth	NE	C	SW	SE	NW
VAWR IMET	V-380WR	V-712WR	V-713WR	V-707WR	V-717WR
1	W-3507	W-3506	W-3665	W-3704	W-3508
10	VM-034	VM-002	SVM-01	SVM-03	S-3709
30	VM-027	VM-023	SVM-16	VM-010	W-3274
50	VM-036	VM-020	SVM-08	SVM-17	W-3288
60	W-2539	W-2541	S-3285	W-3279	W-3296
70	VM-014	VM-013	SVM-15	S-3707	W-3309
80	W-2542	W-2534	W-3263	S-3261	W-3269
90	VM-045	VM-019	SVM-14	S-3706	W-2536
100	W-3280	W-2537	W-3291	S-3714	W-2540
110	VM-035	VM-008	SVM-12	S-3710	ADCP-195 W-2535
130	W-3265	W-2538	S-3310	S-3294	S-3313
150	VM-009	VM-026	SVM-11	S-3715	SVM-09
200	VM-011	VM-025	SVM-18	S-3708	SVM-21
300	S-3260	VM-017	S-3713	S-3712	S-3276
310		VM-031			
400	S-3711	W-2533	S-2430	S-2423	S-3277
580	S-3298	W-3262	W-3299	W-3303	S-3316
750	S-2426	VM-029	S-2429	S-2434	S-3282
1500	S-2427	VM-001	W-3258	W-3341	S-3284
3500		VM-003			

W-# = WHOI Brancker Temperature Recorder
S-#= SIO Brancker Temperature Recorder
VM-# = WHOI Vector Measuring Current Meter
SVM-#= SIO Vector Measuring Current Meter

For the Subduction experiment the WHOI VMCMs in the upper 100 meters were outfitted with cages that had 3/4" cage rods. The deeper instruments had cages with 1/2" cage rods. All cages had a single cross brace to support the sting between the two sets of propellers.

An alternative propeller bearing chosen for use in the Subduction experiment was an all silicon nitride ball bearing (SiNi balls and races with a Duroid ball retainer) available from Miniature Precision Bearing (MPB), of Keene, New Hampshire, as part number J0001-809. This was selected over the typical stainless steel bearing based on previous test results, actual deployments and the fact that the eight month Subduction deployment would be 30% longer than most previous deployments.

The same type of VMCM propellers used in the first setting of the Subduction experiment were used again for the second setting. They were made of an unpigmented Delrin 100 ST which is impact modified. See Trask and Brink (1993) for more details about the bearing and blade materials.

The Subduction 1 VMCMs that were recovered during Oc-250 were in excellent condition with respect to propeller bearings and blades. None of the propellers had broken blades and the silicon nitride bearings were like new. They were in such good condition after the first 8 month deployment that two of the four instruments (VM009 and VM011) that had to be turned around at sea and redeployed used their original stings that had previously been in the water for eight months during Subduction 1. The other two instruments (VM034 and VM035) that were turned around at sea had new stings installed.

The data tapes from seven WHOI VMCMs recovered from the first setting of the Central and Northeast moorings were impossible to read with the equipment aboard ship. The problem was related to a bad batch of certified data cassettes. The data tapes that could not be read had the same code printed on the cassette whereas the readable data tapes had different codes. Five of the seven instruments affected by the bad cassette tapes were on the Central Subduction 1 mooring. They were VM033 at 30 meters, VM038 at 90 meters, VM037 at 150 meters, VM016 at 200 meters and VM015 at 750 meters. The Northeast mooring had two instruments with bad cassettes; VM032 at 70 meters and VM030 at 110 meters. The details of this problem are described in the cruise chronology by mooring.

Temperature Loggers

A total of 58 temperature data loggers manufactured by Richard Brancker Research Ltd. were provided by both WHOI and SIO for the five Subduction moorings. The locations of the loggers are shown in figure 4 and table 4. The loggers provided by WHOI were attached to the mooring line using a hinge type clamp that was tightened around the wire. The SIO clamping arrangement consisted of two 2 piece monel blocks which had been machined to accept the mooring wire. The two pieces were clamped around the wire with .25" hardware.

Several different models were deployed. The SIO 2000 series instruments sampled at 30 minute intervals. The WHOI 2000 series instruments which were modified for extra memory sampled at 15 minutes, and both the SIO and WHOI 3000 series instruments sampled at 15 minutes. The SIO 2000 series instruments had SIO fabricated pressure cases and endcaps.

A total of 15 temperature loggers recovered during Oc-250 leaked a small quantity of water, and the data could not be read. In response to this problem while at sea the instruments that were deployed for the second setting had a vacuum drawn during assembly to better seat the O-rings. This procedure was adopted from SIO whose nearly identical temperature loggers did not display the problem as severely. In addition, the endcaps were tightened considerably more than previously deployed units using a large adjustable wrench. The performance of the temperature loggers recovered from the first setting is described in the Section 3 of this report by mooring on which they were deployed.

ALACE Floats

A total of 11 SIO Autonomous LAgrangian Circulation Explorers were deployed during Oc-250. Details of those deployments can be found in Appendix 5 of this report.

C. Underway Measurements

Expendable Bathythermographs (XBT)

Three hundred XBTs were deployed during Oc-250. The T-7 probes were purchased from Spartan of Canada. XBT data was logged on a NEC APC IV which had a Spartan data acquisition microprocessor card installed. The digital data was simultaneously logged in memory and plotted on the screen. In all there were very few probes that failed to produce reasonable data.

R/V Oceanus transited from Woods Hole to the drifting Southwest buoy before reaching the Subduction site, during this time XBTs were dropped every four hours. Following the deployment of the Southwest mooring XBTs were made hourly. The details of the XBTs can be found in Appendix 6.

Meteorological Observations

From the time the ship left Woods Hole meteorological data from a shipboard IMET system mounted on the bow mast were recorded on optical disk. The IMET sensors included wind speed and direction, seawater temperature (made in the seawater intake of the main engine), barometric pressure, air temperature, relative humidity, precipitation and shortwave radiation. Minute data was logged to a dedicated PC with optical disk. The data was also displayed on the PC monitor.

Manual meteorological observations were also taken hourly on the hour. The manual observations consisted of recording the time, GPS position, ship's speed, ship's heading, wind speed and wind direction from the bridge readout, barometric pressure from the bridge, wet and dry bulb temperatures from a Bendix psychrometer, sea surface temperature from a bucket thermometer, cloud type, and visual cloud cover estimates. Relative humidity was computed using a conversion program on the MacIntosh computer. In addition the corresponding ship mounted IMET data displayed on the PC monitor were also recorded by hand. Information on the shipboard IMET system and a comparison of the data collected with the manual observations is presented in Appendix 7.

Acoustic Doppler Current Profiler

Velocity and temperature data were collected by an Acoustic Doppler Current Profiler mounted in the hull. See Appendix 8 for a summary of the data files collected.

Section 3: Cruise Chronology

Oceanus cruise number 250 departed Woods Hole on Saturday, 25 January 1992 at 1130 UTC. The purpose of the cruise was to recover and redeploy an array of five surface moorings deployed in June/July 1991 as part of the ONR funded ASTEX and Subduction Experiment. This was the second of four scheduled mooring cruises planned for this experiment. Details of the cruise are described below by mooring. For an abridged version of the cruise chronology see Appendix 9.

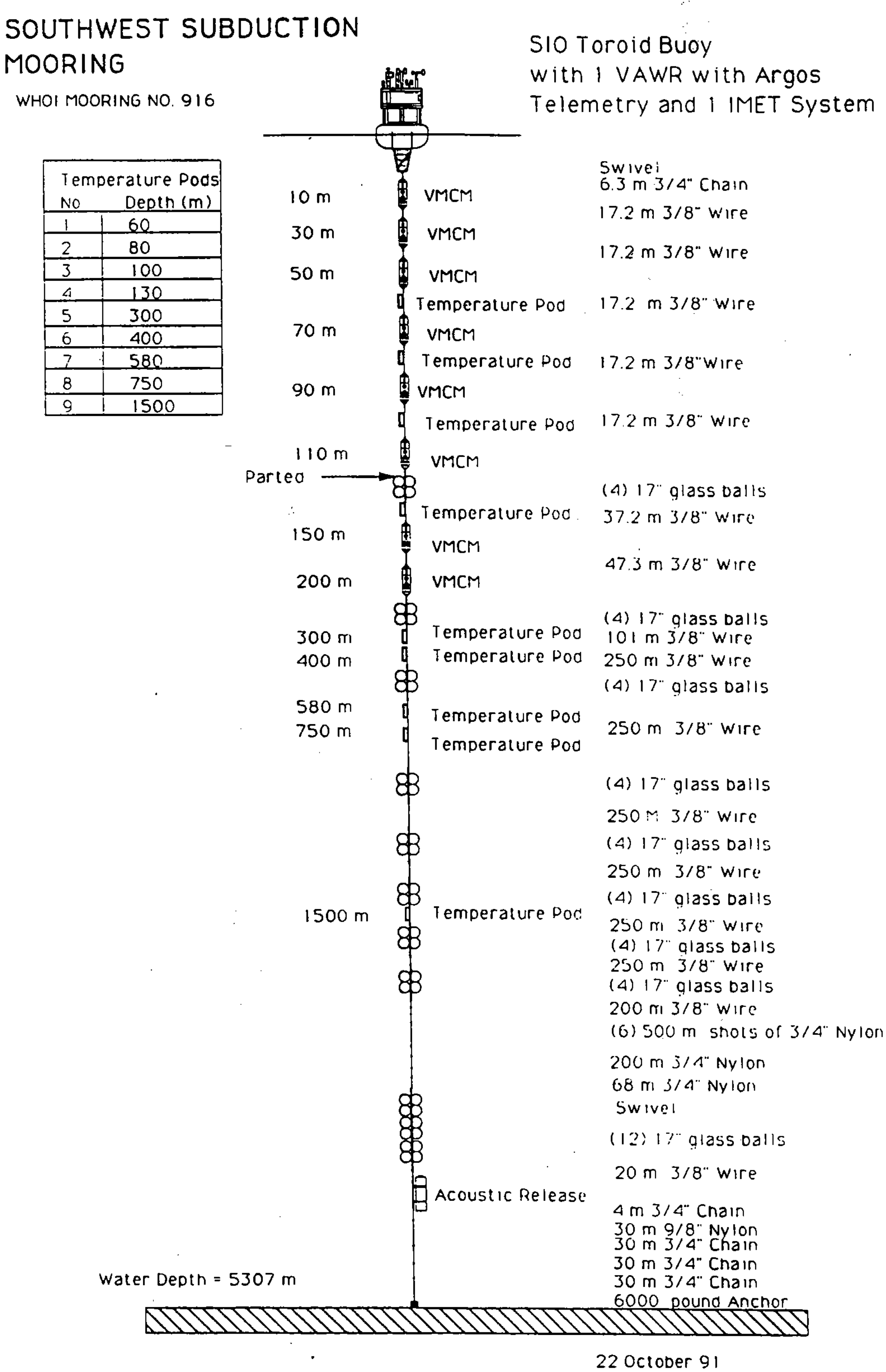
Southwest Mooring

The Oceanus arrived at the drifting toroid buoy at 0515 UTC on Sunday, 2 February 1992 at position 15°13.09'N, 44°47.48'W. The buoy's marine lantern was first sited at a distance of approximately 5 miles . After a brief opportunity for fishing the buoy and parted mooring were brought aboard. Figure 5 is a schematic of the mooring as it was deployed in June 1991. An XBT (#44) was taken while along side the buoy prior to recovery. A total of 6 SIO Vector Measuring Current Meters (VMCMs at 10m, 30m, 50m, 70m, 90m, and 110m), 2 WHOI Brancker temperature recorders (80m, 100m) and 1 SIO Brancker temperature recorder (60m) were recovered. The last item to be recovered was the 110 meter current meter which did not have a shackle in the bottom bale. The top bale of the 110 meter VMCM had a shackle and bolt but had lost its nut and cotter pin. The titanium pin in the lower bale of the 110 m VMCM was extremely worn. In addition to the load cage wear the VMCM sting (orthogonal propeller assembly) was missing from the instrument which caused the instrument to flood. Both WHOI Brancker temperature recorders (#3279 at 80 m and #3303 at 100 m) as well as the SIO Brancker (#3314 at 60 m) were opened and the data read without any problem. The VAWR meteorological package recorded data the entire time the buoy was on station but failed on 30 November 1991.

With the upper part of the mooring aboard the Oceanus got underway at 0730 UTC for the original Southwest mooring site at 18°00.03'N, 33°59.96'W. The ship arrived at the site on 4 February 1992 at 1152 UTC. Upon arriving at the site the location of the anchor was checked by ranging on the acoustic release from approximately 2 miles away. The range obtained confirmed the original anchor position obtained during the setting cruise in June/July 91. The ship was then positioned one-half mile down wind of the anchor position and the release was fired at 1235 UTC. Confirmation of release was not detected right away. A continual decrease in slant ranges indicated that the release was rising. Slant ranges to the release were monitored the entire time the mooring was coming to the surface. The ship continued to drift away from the site and had to be repositioned to the location where the release was fired several times. A set of 4 glass balls was sited at 1332 UTC. One by one the clusters of 4 balls were spotted strung out in line with the wind direction. All but two clusters were sited. The ship then cautiously proceeded parallel to the mooring until the large bottom cluster of 12 balls was spotted. Recovery of the bottom of the mooring was initiated at 1430 UTC. By 1843 UTC the entire parted mooring was on board. The uppermost part of the mooring was a cluster of 3 glass balls (one of the original four was missing and those remaining had cracked hardhat flanges), a shackle with master link and the top shackle with no bolt in place. The top shackle was originally attached to the bottom of the 110m VMCM that was recovered below the drifting buoy. The entire mooring was therefore recovered.

The lower part of the mooring contained 4 SIO Brancker Temperature Recorders (at 130m, 300m, 400m, 750m), 2 SIO VMCMs (at 150m and 200m) and 2 WHOI Brancker Temperature Loggers (at 580m and 1500m). WHOI temperature logger #3287 at 1500m and SIO temperature logger #2436 at 750m had several drops of water inside when the instruments were opened. The water appeared to have just entered the pressure case sometime during recovery since there was no indication of corrosion. The data however could not be read from these instruments. This

Figure 5. Subduction 1 Southwest Mooring Schematic



particular SIO Brancker that leaked had an SIO fabricated pressure case and endcaps. Inspection of the pressure case face seals revealed markings in the anodizing. The same pressure case design as that used by Brancker was also used to fabricate the SIO pressure case. All SIO purge plugs were not the standard Brancker issue. SIO replaced the Brancker purge plug with one fabricated of Ertalyte (P.E.T.).

With the mooring aboard attention was turned to preparing for redeployment. The deck was cleared and off-spooling the wire on the winch was begun. Simultaneously three acoustic releases were wire tested using the CTD winch. Two SIO releases and one WHOI release were tested to a depth of 1000 meters. These operations were followed by rewinding the wire and nylon for the next mooring. The mooring schematic for the second setting of the Southwest mooring is shown in figure 6. Due to space limitations on the TSE winch drum only the upper 3200 meters of wire and nylon were wound on the winch. While the winding was taking place the ship was positioned 7 miles to the south southwest. This was downwind of the target and slightly south to compensate for a small northerly current.

The deployment of the upper instrumentation (10m and 30m VMCMs) and buoy (in that order) went quite smoothly. With the buoy in the water the ship initially had just enough way on to maintain steerage. As more instrumentation and wire were deployed the speed through the water was increased to .5 knot and then to 1.0 knot. Mid-way through the deployment the mooring was towed while 1800 meters of nylon and 500 meters of polypropylene were wound onto the winch. During towing the ship's speed was decreased to .7 knot due to an increase in the tension in the nylon. This speed was maintained as the remainder of the mooring was deployed.

With the reduction in the ship's speed, progress over the bottom was slower than expected. The mooring had been cut for deployment in water similar to the original water depth of 5307 meters. The plan was to continue to tow until the water depth was within 40 meters of the planned depth. Unfortunately during our approach the water was several hundred meters shallower than what was needed. Towing had to continue at a slow pace until the design depth was obtained. As the ship approached the original target the water depth increased for a sufficient distance to permit the deployment of the mooring. The anchor was deployed at 1318 UTC on 5 February 1992.

Following the anchor deployment the ship was repositioned to watch the toroid buoy ride through the water as the anchor went to the bottom. The toroid behaved considerably different during this deployment than it had in previous deployments in June/July 91. In comparison with the Subduction 1 toroid deployments the speed through the water was much less (.7 kt), the toroid was not heeled over as much, and it did not submerge.

Two hours of intense meteorological observations were made as the buoy settled into position. Meteorological observations were obtained by hand held and bridge mounted sensors and logged with the IMET data every 15 minutes. At the same time the VAWR Argos transmissions were received directly from the buoy via the Telonics receiver aboard ship. These data were compared at the end of the two hour period. All observations compared well. These observations are used as a final check of instrument performance before leaving the site.

An acoustic release survey followed. Three positions were selected approximately 2-3 miles away from the suspected anchor location. From each position a horizontal range to the release was obtained. Figure 7 shows the results of the survey which located the anchor of the **Southwest mooring (WHOI Mooring number 924) at 17°59.93'N and 34°00.65'W.** Following the survey the acoustic release was disabled and confirmation obtained. The anchor fall back for this mooring was 238 meters or 4.5% of the water depth. The water depth at the site was 5300 meters corrected. The total depth correction was +50 meters (+3 transducer depth + 47 Matthew's correction) and the sound speed used was 1514 m/sec.

Figure 6. Subduction 2 Southwest Mooring Schematic

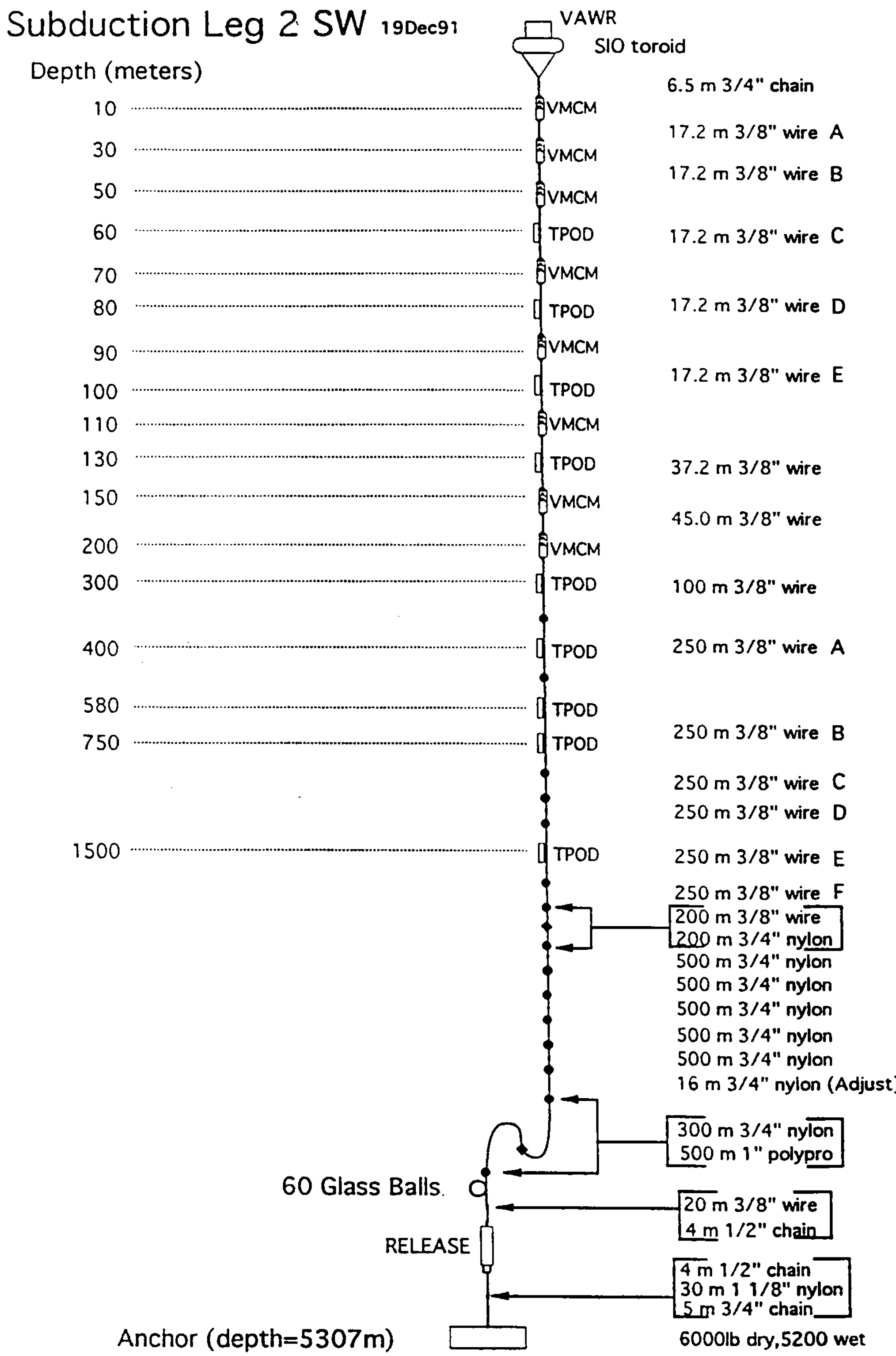


Figure 7. Subduction 2 Southwest Acoustic Release Survey