

DF-94 TECHNICAL CRUISE REPORT  
SEDIMENT TRAP RECOVERY/DEPLOYMENT CRUISE  
ROSS SEA, ANTARCTICA  
U.S.C.G.C. POLAR SEA (JAN. 16 TO FEB. 17, 1994)

by

David A. Mucciarone

Cruise Participants: Robert B. Dunbar, David A. Mucciarone, Jennifer C. Rogers, Leonardo Langone, and Luca Masini (all S-216).

**U.S.C.G.C. POLAR SEA:**

We departed Houston on 1/16/94 and arrived in Christchurch, NZ on 1/18/94. All participants arrived in McMurdo Station on 1/19/94. Most of 1/20/94 was spent preparing for the cruise that was to include 2 mooring recoveries, 1 mooring recovery, and collection of seawater for POC, PON, DIC, and phytoplankton taxonomy. Our proposed cruise start and end dates were 1/22/94 to 1/29/94. Later on 1/20, around 2030 Dunbar and Mucciarone boarded the U.S.C.G.C. Polar Sea to assist S-147 (Yoshi Takahashi and Steve Peterzen) in dragging for their lost balloon payload. The main objective was to retrieve the emulsion chambers containing photographic emulsion plates and x-ray film. The search was called off at about 1800 on 1/21 ending a 21.5 hour dragging operation. Before docking in McMurdo we had the U.S.C.G.C. Polar Sea break ice as close to the S4 McMurdo Sound mooring site as possible.

The 22nd was spent preparing for the cruise and for the Coast Guard helicopter flight to the McMurdo Sound mooring site (Acoustic release deck unit, echo sounder, ice drill, battery, etc.). At around 2200, Dunbar, Mucciarone, and Rogers left on a helo flight to interrogate the release on the S4 McMurdo Sound mooring. Unfortunately we were not able to communicate with the acoustic release, but were able to locate the mooring with the Furuno echo sounder and flag the location. We returned to McMurdo at about 0200 on 1/23/94. The information on the McMurdo Sound mooring is described in detail in Appendix A.

**LEG 1:**

We finished loading the rest of our equipment on the Polar Sea on 1/24 (already delayed 2 days) and the ship left the dock at 1300. The remainder of the day was spent preparing the sediment traps (rope splicing, installing cups, checking pressure cases, testing acoustic releases, etc.), setting up the filtering rig, and a ship orientation and cruise meeting. The 25th and 26th more of the same, mooring preparation (program traps, prepare floats, repair and test releases). However, since we were being delayed because of the tanker off load, we had the Polar Sea break ice around the S4 McMurdo Sound mooring site. On the 26th the Polar Sea pulled the tanker from the pier and escorted it north of Cape Byrd. During the escort the tanker bent a blade on its propeller which required Coast Guard divers to inspect and evaluate the damage. We released the tanker at approximately 2100, allowing the tanker to limp back to NZ at 7 knots. Late in the day we made our first CTD cast, and by the days end we arrived at Site A to find it in 90 to 100% ice

cover. We spent most of the 27th breaking ice around Site A and attempting to communicate with the release. We were relieved to find the mooring apparently in working order and received a slant range of 762 m. We were not able to make a recovery because of the extensive ice cover. See Appendix B for notes on the recovery attempts at Site A and the reasons for the delays. The 27th was not without interruption, we lost about 6 hours to air evacuate a crew member for a family emergency in the states. Late on the 27th we postponed the Site A recovery and began our west to east transect along Latitude  $76^{\circ} 30'S$  to our old Site B mooring location.

Our objective along this transect was to collect seawater samples from Niskin bottles and filter for POC and PON, collect 40 ml aliquots of seawater for DIC, and 125 ml seawater samples for phytoplankton taxonomy (Samples: Station 1 through Station 20; Appendix F). The transect was interruption free until 2100 on 1/29 when the Polar Sea was instructed to assist the tanker and cargo vessel both in heavy seas and ice approximately 315 miles to the north. We began taking seawater samples for POC and DIC using the uncontaminated seawater system every hour during the transit north to the tanker (Samples: T-1 through T-12; Appendix F). By the time we reached the tanker the storm had passed, there was no need for assistance from the Polar Sea. In addition, the cargo vessel did not require assistance at this time, McMurdo released us on 1/30. At this point, the Polar Sea headed south to Site A. We continued to take seawater samples for POC and DIC using the uncontaminated seawater system every hour during this southern transit (Samples: T-13 through T-33; Appendix F). On the 30th we held a deployment meeting and then made final preparations to the new mooring deployment.

We arrived at our new Site A, I will call it Site A', at 1030 on the 31st. The deployment went relatively well finishing the deployment at 1445 (See Appendix C for Site A' mooring details). As soon as we finished the Site A' deployment, we began our search for the mooring at Site A. After a number of hours tracking the set and drift of the ice around the mooring site, we decided to launch the MSB at 0130 on 2/1/94. About 2 hours were spent attempting to triangulate and locate the mooring. Much time was lost trying to negotiate the MSB around the ice. The closest slant range obtained was 778 m, with the Site A location under 95+% ice cover. The MSB was brought aboard at 0330 (Appendix B). We spent another 4 hours tracking the ice with the anticipation of an open area passing over the site, this did not happen. At 0730 on the 1st we began our E/W/E transect to the old Site B mooring location, where we collected seawater samples for POC and DIC every hour using the uncontaminated seawater system (Samples: T-34 through T-65; Appendix F).

We arrived near Site A to meet the cargo vessel M/V Green Wave late on the 2nd for an escort through the sea ice around Cape Byrd, into McMurdo Sound, and to the pier. The Polar Sea did not dock along side the Green Wave. All PAX were transferred to McMurdo Station by Coast Guard helo on the morning of the 3rd. Dunbar, Langone, and Masini were transported to land, and Mucciarone and Rogers stayed aboard the Polar Sea with Stan Jacobs' group until the 12th. Mucciarone temporarily left the Polar Sea to pick up additional supplies for the second leg (another deck unit and transducer).

## **LEG 2:**

Around 1300 we left McMurdo Sound to begin the unscheduled second leg of our cruise with Stan Jacobs as the Chief Scientist. Before we could begin this leg we had to meet up with the R/V Palmer to obtain so need equipment for Jacobs' group. On 2/4/94 at 1200 we met the R/V

Palmer near our old Site B mooring location, transferred gear, and then continued southeast towards the Ross Ice Shelf. Our intention on this leg was to collect seawater from the Niskin casts and filter for POC and collect 40 ml samples for DIC. Additionally, we were hopeful that the ice around Site A would break up enough to allow for a recovery. Satellite photos were review about every other day.

The first transect station began at 77° 53.77'S 158° 50.81'W on 2/5/94 at 0600 and continued westward along the Ross Ice Shelf to 77° 10.74'S 167° 46.27'E on 2/10/94 at 1130 (Samples: Station 1 through Station 42, approximately every other station; Appendix F). Unlike our first cruise leg, the second leg went uninterrupted until 2/12/94 when we were scheduled to assist the M/V Green Wave off the pier and meet with the R/V Palmer at the pier in McMurdo. By the time we arrived at Site A we had approximately 14.5 hours (2130 on 2/10 until 1200 on 2/11) to locate and recover the mooring. Under normal conditions this would have been plenty of time, but give the ice conditions this year this was not enough time to negotiate the dense ice cover for a safe recovery.

#### Site A Mooring Recovery Attempt:

We arrived on Site A at 2130 on 2/10/94 to attempt another mooring recovery. Once in the area we attempted to locate the mooring site with the Polar Sea by acoustically interrogating the release from the bow. Ice cover in the area was improved from the previous attempt, around 80 to 100% (Appendix D). Large open water areas were present in the ice (largest 1 x 3 miles), but were very unstable. Within 30 to 45 minutes these open water areas would change shape (sheering, compressing) making an optimistically large open area unsuitable for a recovery. We located the mooring (slant range 801 m) and tracked the set and drift of the ice and determined the movement was south to southwest at 0.5 to 1.0 knots, winds were stable at less than 3 knots. Ice cover over the site at this time was 90+%. At 2200 the ship relocated to an open water area updrift of the mooring site to launch the MSB. After 2.5 hours in the MSB the closest slant range acquired was 810 meters, ultimately being hindered by 100% ice cover. The MSB was experiencing a number of problems during the triangulation and eventually would not start due to a dead battery. The MSB was rowed to the Polar Sea for retrieval at 0030. Once on board we again scouted the area for open water up drift from the mooring. About 2 miles from the site was an open water area approximately 1 across by 3 miles long. After moving to the site we launched the ASB (began at 0310, launched at 0420). Our ASB search began at 0430, but by this time the open area had changed shape, collapsed and was now about 0.1 miles across and 2 miles long. The closet slant range was 1224 meters. Keeping the ASB in the water, we used the Polar Sea to cut a channel to Site A, eventually getting a slant range from the ASB of 778 meters, with the projected site directly under the Polar Sea. Ice cover at this time was greater than 95% with no open water areas large enough for a recovery within the radar range. At this point I came aboard the Polar Sea to help scout for a suitable open water area, leaving the ASB in the water trailing behind the Polar Sea during our search.

During our search for open water we located the release (DAVE) deployed in 1991 from the Polar Sea which unfortunately was not recovered during our successful dragging operation in 1992. This release (DAVE) in 1992 appeared to work correctly by transponding strongly and sending the double ping release response, however, did not release the bottom weight. Evidence from the bottom of the recovered mooring suggested that XBT wire prevented the release

mechanism from working properly. The release was never rearmed, therefore, was armed for 2 years. We obtained a slant range of 809 meters, and by quick triangulation using the Polar Sea and ASB confirmed the 1991 mooring site. To further verify that this release was DAVE, the rearm code BEFH was transmitted, after, the release would no longer communicate to the deck unit.

The good news behind all this is that the release (Inter Ocean 1090ED) with 8 Electrochem lithium D cell batteries was still communicating strongly after 3 years. This means that it is possible that the 1992 mooring releases (Two Inter Ocean 1090E with 6 Electrochem D cell batteries each) may still work in 1995 especially if they have been turned off throughout their deployment. Both releases at the 1992 Site A mooring are communicating, however throughout our search we have only been using PAUL (Enable: DEF; Rearm: DEFH; Release: ACEH), CARRIE (Enable: DEG; Rearm: DEGH; Release: ADFG) was rearmed immediately after verifying it was working properly.

At this time it was 0700 and we are no closer to recovering the mooring. Captain Brigham had also informed me at this time that we only have until 1200 to make/attempt a mooring recovery because we are scheduled to escort the M/V Green Wave at 0700 on the 12th and meet the R/V Palmer at the pier by 1200. Considering our distance from McMurdo and our appointment time with both ships, we had at least another 6 hours (until 1800). This according to the Captain was not so and 1200 was the final word on the matter. We would have no her luck or cooperation from the ice, meaning no open water area large enough for a recovery would pass over the site. At 1200 we began the recovery of the ASB and the Polar Sea was underway for McMurdo Station by 1330

Notes on S4 McMurdo Sound Mooring:

We arrived at McMurdo around 0030 on the 12th. The ship set in the ice near the S4 McMurdo Sound mooring location. Taking advantage of what little time I had remaining, I attempted some soundings from the Polar Sea to the S4 mooring. Unlike our helo trip on 1/23, I was able to communicate with the release. It should be noted that the gain on the deck unit was near maximum and communication with the release was not consistent. Occasionally, about every third transpond an OVER or large slant range was returned. The return ping also sounded a little different than any of the other Inter Ocean 1090E or 1090ED releases. This could be why we had difficulty communicating with the release during our helo trip, although hull interference is also a possibility (Appendix A).

The slant ranges received from the Polar Sea to the S4 mooring were from the Stern 475 m, starboard midship 448 m, port midship (casting deck) 431 m, starboard bow 421m, port bow 405 m. After plotting the horizontal distances of (447 m, 418 m/400 m, 390 m/372 m) with respect to the sounding positions from the ship, we confirmed the S4 mooring location. The S4 mooring site has approximately 400 meters radius of open water to the south, west and north with the east completely open. Before attempting a recovery, I wanted to verify if the mooring was still to be recovered. I made an attempt of call Rob in Houston via INMARSAT with no luck (poor satellite link from Polar Sea in McMurdo Sound) and also tried to get in touch with Steve Kottmeier and Kristin Larson with no success. It was 0300 by this time and the Captain said I did not have any time left for a recovery especially if problems occurred during the recovery. I had to agree, if the release or the float package did not work properly we would have to drag using the

ASB because there was not enough open area for the Polar Sea. A recovery at this time would be risky considering the Polar Sea commitments with the M/V Green Wave and R/V Palmer.

The Green Wave left the pier at 0800 and did not need any assistance off the pier or need an escort out of McMurdo Sound. The Polar Sea docked at 0900. At 0930 I talked with Steve and Kristin concerning the S4 mooring. Kristin was willing to make the recovery of the S4 mooring, but hesitated on re-deploying the mooring. Steve pushed to leave the mooring in to collect data for 2 years, and if recovered, wanted it redeployed. The problem he had with the redeployment from ship was getting an accurate fix on the mooring for a sea ice recovery next season. The next question was ship time. The Polar Sea would be available on the 18th, 22nd, and depending on the Green Wave other dates could be made available. When I left the ice on 2/16, the decision was to leave the S-4 mooring in until next season.

The remainder of the time 2/12-16/94 was spent returning gear to the Crary Lab, preparing samples for the ComAir flight to Houston, and preparing gear for the return to Seattle on the Polar Sea for later shipment to Rice.

### **MOORING A DEPLOYMENT: (February 11, 1992)**

Information on the mooring equipment at Site A. The releases, trap pressure cases, trap programming, and sediment traps cups were prepared by David Mucciarone. Assembly of the mooring line to the equipment and deployment was performed by Robert Dunbar. Mooring A statistics (refer to Appendix E for more details):

Deployment Filename: **A-FEB92D.TOP**  
Battery Condition: 9.20VDC (Micro 9v alkaline, 3/ea.)  
3.23VDC (RAM 3v lithium, 1/ea.)  
9.21VDC (Motor 9v alkaline, 4/ea.)

Deployment Filename: **A-FEB92D.BOT**  
Battery Condition: 9.23VDC (Micro 9v alkaline, 3/ea.)  
3.22VDC (RAM 3v lithium, 1/ea.)  
9.21VDC (Motor 9v alkaline, 4/ea.)

Acoustic Releases 1090E: Paul-2 pack = 7.7VDC; 4 pack = 7.55VDC  
Battery Condition: Carrie-2 pack = 7.6VDC; 4 pack = 7.57VDC

Program Schedule: Deployed Sediment Traps at Site A (TOP and BOTTOM).

Cup 1	Timer begins on 2/11/92 at 00:06:00 (Top). Timers begin on 2/11/92 at 00:06:00 (Bottom). Actual deployment time: 10:13:00 on 2/11/92.		
Cup 2	22 days	Event 1	01MAR92
Cup 3	52	Event 2	31MAR92
Cup 4	83	Event 3	01MAY92
Cup 5	144	Event 4	01JUL92

Cup 6 206  
 Cup 7 267  
 Cup 8 328  
 Cup 9 342  
 Cup 10 359  
 Cup 11 373  
 Cup 12 387  
 Cup 13 493  
 Cup 14 615  
 Cup 15 693

Event 5 01SEP92  
 Event 6 01NOV92  
 Event 7 01JAN93  
 Event 8 15JAN93  
 Event 9 01FEB93  
 Event 10 15FEB93  
 Event 11 01MAR93  
 Event 12 15JUN93  
 Event 13 15OCT93  
 Event 14 01JAN94

Cup Poisoning Solution:

10% Na-borate solution of formalin with filtered sea water.

Mooring Statistics:

Top float to 8 float package = 10m  
 8 float package to top trap = 25m  
 Top trap to 6 float package = 375m  
 6 float package to bottom trap = 105m (80m+25m)  
 Bottom trap to release float = 25m  
 Release float to acoustic releases = 10m  
 Acoustic releases to 1400lb anchor = 4.5m  
 (1.5m SS sling with 3m 1/2" chain)  
 All rope is Sampson 3/8" VLS Duron

Release Command Codes:

<b>CARRIE</b>	<b>PAUL</b>
<b>Enable=DEG</b>	<b>Enable=DEF</b>
<b>Release=ADFG</b>	<b>Release=ACEH</b>
<b>Rearm=DEGH</b>	<b>Rearm=DEFH</b>

**Mooring Location:**

**76° 31.501'S 167° 23.42'E (GPS) @ 840m Slant Range**

**Water Depth:**

**800 meters**

**MOORING A' DEPLOYMENT: (January 31, 1994)**

David Mucciarone, Robert Dunbar, Leo Langone, Luca Masini, and Jennifer Rogers all participated in the preparation of the mooring line. Mucciarone and Dunbar performed the sediment trap and acoustic release preparation. Langone and Masini performed the SeaBird CTD and AAnderaa current meter preparation. Mucciarone assembled the mooring components (floats, rope, traps, CTD's, current meters, releases, and weight. Mucciarone and Dunbar directed the mooring deployment. Mooring A' statistics:

Deployment Filename:

**ATOP94.TRP**

Battery Condition:

9.30VDC (Micro 9v alkaline, 3/ea.= 9.14v)  
 3.24VDC (RAM 3v lithium, 1/ea.)

Tests: 9.41VDC (Motor 9v alkaline, 4/ea.= 18.60v)  
TTRUN15.TCR, MOTORJOG.RUN, TTCLOCK

Deployment Filename: **ABOT94.TRP**

Battery Condition: 9.31VDC (Micro 9v alkaline, 3/ea.= 9.04v)

3.24VDC (RAM 3v lithium, 1/ea.)

9.39VDC (Motor 9v alkaline, 4/ea.= 18.32v)

Tests: TTRUN15.TCR, MOTORJOG.RUN, TTCLOCK

Acoustic Releases 1090ED: Luisa-2 pack = 7.32VDC; 4 pack = 7.33VDC

Battery Condition: Robyn-2 pack = 7.36VDC; 4 pack = 7.29VDC

Program Schedule: Deployed Sediment Traps at Site A (TOP and BOTTOM).

Timer begins on 1/26/94 at 15:48:25 (Top).

Timer begins on 1/26/94 at 16:38:00 (Bottom).

Actual deployment time: 14:49:29 on 1/31/94.

Cup 1	0	Event 0	31JAN94
Cup 2	14 (Cup 1 to Cup 2)	Event 1	10FEB94
Cup 3	16 (Cup 2 to Cup 3)	Event 2	26FEB94
Cup 4	16	Event 3	14MAR94
Cup 5	17	Event 4	31MAR94
Cup 6	31	Event 5	01MAY94
Cup 7	31	Event 6	01JUN94
Cup 8	44	Event 7	15JUL94
Cup 9	48	Event 8	01SEP94
Cup 10	39	Event 9	10OCT94
Cup 11	41	Event 10	20NOV94
Cup 12	30	Event 11	20DEC94
Cup 13	15	Event 12	04JAN95
Cup 14	97	Event 13	01APR95
Cup 15	?	Event 14	01AUG95

Cup Poisoning Solution: 10% Na-borate solution of formalin with filtered sea water.

Mooring Statistics:

Top 30" steel float (+369#)	=	0.3 m
Top 30" steel float to top trap	=	10 m
Top trap w/ pendant (-20#)	=	25 m
Bottom of top trap to top CTD	=	5 m
Top CTD meter (-32#)	=	0.85 m
Top CTD meter to top current meter	=	5 m
Top current meter/transmissometer (-40#)	=	0.45 m
Bottom of current meter to triple 3 pack floats	=	60 m

Triple 3 pack floats (+198#)	= 1.5 m
Triple 3 pack floats to double 3 pack floats	= 350 m
Double 3 pack floats (+132#)	= 1.0 m
Double 3 pack floats to bottom trap	= 100 m
Bottom trap w/ pendant (-20#)	= 25 m
Bottom of bottom trap to top CTD	= 5 m
Bottom CTD meter (-32#)	= 0.9 m
Bottom CT meter to bottom current meter	= 5 m
Bottom current meter/transmissometer (-40#)	= 0.45 m
Bottom of current meter to single 3 pack floats	= 10 m
Single 3 pack floats (+66#)	= 0.5 m
Single 3 pack floats to top release (LUISA)	= 10 m
Top release (-20#) LUISA	= 0.6 m
Top release to bottom release (1/2" SS sling)	= 2.5 m
Bottom release (-20#) ROBYN	= 0.6 m
Bottom release to 1400lb anchor (1/2 gal. chain)	= 4.5m
All rope is Sampson 3/8" VLS Duron w/ 5/8" nylon thimbles	
Hardware: 12-1/2" galvanized chain shackles	
02-1/2" stainless steel trap shackles	
04-1/2" stainless steel anchor shackles	
04-3/8" stainless steel chain shackles	
01-1/2" stainless steel swivel	
01-1/2" Crosby master link	

Release Command Codes:	<b>LUISA</b>	<b>ROBYN</b>
	<b>Enable=DEF</b>	<b>Enable=DEF</b>
	<b>Release=BEFH</b>	<b>Release=BEGH</b>
	<b>Rearm=DEFH</b>	<b>Rearm=DEFG</b>

**MOORING A' DEPLOYMENT SCHEDULE: (January 31, 1994)**

**Mooring A:** Recovered by dragging.

Date	Stn	Latitude	Longitude	Time
1/31/94	A'	76° 40.96'S	169° 00.90'E	2106

On Station @	1030
Launched MSB @	1120
Top 30" steel float @	1200
Top sediment trap @	1213
Top CTD meter @	1216
Top current meter/transmissometer @	1217
Pay out 60 m of VLS Duron rope	
Triple 3 pack of floats @	1235
Pay out 350 m of VLS Duron rope	



Double 3 pack of floats @	1405
Pay out 100 m of VLS Duron rope	
Bottom sediment trap @	1425
Bottom CT meter @	1428
Bottom current meter/transmissometer @	1429
Single 3 pack of floats @	1435
Top and Bottom release assembly	1436
Weight 1400# released @	1443
Top 30" steel float disappeared below surface @	1449

**Mooring Location:** 76° 40.96'S 169° 00.90'E (GPS)

**Water Depth:** 800 meters

## APPENDIX F

Station #	Date	Time (L)	Latitude	Longitude
<b>LEG 1:</b>				
Test	1/26/94		77° 47.98'S	166° 27.40'E
Site A	1/27/94		76° 30.38'S	167° 27.68'E
Test	1/27/94		76° 32.02'S	167° 20.70'E
6	1/28/94		76° 29.56'S	168° 42.10'E
7	1/28/94		76° 29.83'S	169° 50.54'E
8	1/28/94	1245	76° 29.98'S	171° 00.30'E
9	1/28/94	1530	76° 30.00'S	172° 10.00'E
10	1/28/94	1740	76° 30.00'S	173° 20.00'E
11	1/28/94	2033	76° 30.00'S	174° 30.00'E
12	1/28/94	2340	76° 29.89'S	175° 39.97'E
13	1/29/94		76° 30.15'S	176° 49.17'E
14	1/29/94		76° 29.91'S	177° 59.26'E
15	1/29/94		76° 29.87'S	179° 08.63'E
16	1/29/94		76° 30.01'S	179° 40.80'W
17	1/29/94	1315	76° 30.00'S	178° 30.00'W
18	1/29/94	1545	76° 30.00'S	177° 20.00'W
19	1/29/94	1815	76° 30.00'S	176° 10.00'W
20	1/29/94		76° 30.00'S	175° 00.00'W
TS-1	1/29/94	2300	76° 03.70'S	175° 22.95'W
TS-2	1/30/94	0000	75° 50.76'S	175° 31.12'W
TS-3	1/30/94	0100	75° 36.09'S	175° 38.99'W
TS-4	1/30/94	0200	75° 20.38'S	175° 46.69'W
TS-5	1/30/94	0700	73° 58.80'S	176° 27.54'W
TS-6	1/30/94	0800	73° 47.12'S	176° 34.54'W
TS-7	1/30/94	0900	73° 31.26'S	176° 44.67'W
TS-8	1/30/94	1000	73° 18.83'S	177° 01.78'W
TS-9	1/30/94	1100	73° 03.35'S	177° 33.72'W
TS-10	1/30/94	1200	72° 46.39'S	177° 23.11'W
TS-11	1/30/94	1300	72° 33.54'S	177° 02.69'W
TS-12	1/30/94	1400	72° 29.60'S	177° 08.14'W
TS-13	1/30/94	1500	72° 41.49'S	177° 48.35'W
TS-14	1/30/94	1600	72° 53.57'S	178° 29.03'W
TS-15	1/30/94	1700	73° 06.94'S	179° 07.14'W
TS-16	1/30/94	1800	73° 19.86'S	179° 43.93'W
TS-17	1/30/94	1900	73° 32.62'S	179° 34.64'E
TS-18	1/30/94	2000	73° 45.15'S	178° 55.16'E
TS-19	1/30/94	2100	73° 57.86'S	178° 16.67'E
TS-20	1/30/94	2200	74° 11.91'S	177° 33.41'E
TS-21	1/31/94	2300	74° 23.69'S	176° 56.38'E
TS-22	1/31/94	0000	74° 36.55'S	176° 15.90'E
TS-23	1/31/94	0100	74° 50.27'S	175° 30.51'E

Station #	Date	Time (L)	Latitude	Longitude
<b>LEG 1:</b>				
TS-24	1/31/94	0200	75° 03.84'S	174° 47.23'E
TS-25	1/31/94	0300	75° 17.33'S	174° 02.47'E
TS-26	1/31/94	0400	75° 30.16'S	173° 18.25'E
TS-27	1/31/94	0500	75° 44.12'S	172° 29.51'E
TS-28	1/31/94	0600	75° 58.31'S	171° 40.13'E
TS-29	1/31/94	0700	76° 10.13'S	170° 58.30'E
TS-30	1/31/94	0800	76° 22.37'S	170° 13.96'E
TS-31	1/31/94	0900	76° 36.00'S	169° 29.05'E
TS-32	1/31/94	1000	76° 43.33'S	168° 36.03'E
Site A'/TS-33	1/31/94	1430	76° 40.93'S	169° 00.81'E
Site A'/23	1/31/94	1555	76° 40.93'S	169° 00.81'E
24	1/31/94		76° 31.69'S	167° 22.77'E
TS-34	2/01/94	1100	76° 31.39'S	167° 43.70'E
TS-35	2/01/94	1200	76° 29.70'S	168° 02.36'E
TS-36	2/01/94	1330	76° 30.17'S	169° 37.99'E
TS-37	2/01/94	1400	76° 30.26'S	170° 10.24'E
TS-38	2/01/94	1500	76° 30.09'S	171° 00.44'E
TS-39	2/01/94	1600	76° 29.61'S	171° 30.35'E
TS-40	2/01/94	1700	76° 29.87'S	172° 52.96'E
TS-41/27	2/01/94	1800	76° 29.71'S	173° 20.94'E
TS-42	2/01/94	1900	76° 29.55'S	174° 25.62'E
TS-43	2/01/94	2000	76° 29.89'S	175° 38.28'E
TS-44	2/01/94	2100	76° 29.52'S	176° 10.49'E
TS-45	2/01/94	2200	76° 29.64'S	177° 20.50'E
TS-46	2/01/94	2300	76° 29.63'S	178° 01.79'E
TS-47	2/02/94	0000	76° 29.21'S	179° 20.99'E
TS-48	2/02/94	0100	76° 29.61'S	179° 37.33'W
TS-49	2/02/94	0230	76° 29.77'S	178° 37.81'W
TS-50	2/02/94	0410	76° 29.82'S	177° 18.54'W
TS-51	2/02/94	0500	76° 29.18'S	176° 24.91'W
TS-52	2/02/94	0600	76° 29.67'S	175° 18.83'W
TS-53	2/02/94	0700	76° 29.44'S	175° 00.18'W
TS-54	2/02/94	0800	76° 31.59'S	176° 06.37'W
TS-55	2/02/94	0900	76° 33.73'S	177° 18.89'W
TS-56	2/02/94	1000	76° 35.52'S	178° 32.07'W
TS-57	2/02/94	1100	76° 37.21'S	179° 46.27'W
TS-58	2/02/94	1213	76° 37.28'S	178° 41.52'E
TS-59	2/02/94	1300	76° 37.00'S	177° 43.65'E
TS-60	2/02/94	1400	76° 36.58'S	176° 28.10'E
TS-61	2/02/94	1500	76° 36.04'S	175° 16.58'E
TS-62	2/02/94	1657	76° 35.21'S	171° 53.02'E
TS-63	2/02/94	1915	76° 34.42'S	170° 02.38'E
TS-64	2/02/94	2012	76° 48.29'S	169° 23.83'E

Station #	Date	Time (L)	Latitude	Longitude
<b>LEG 1:</b>				
TS-65	2/02/94	2100	76° 59.95'S	168° 59.98'W
<b>LEG 2:</b>				
Test	2/04/94		77° 07.48'S	166° 07.83'W
1	2/04/94	0600	77° 53.77'S	158° 50.81'W
5	2/05/94	1847	78° 16.53'S	162° 44.76'W
7	2/06/94		78° 15.63'S	166° 29.72'W
9	2/06/94		78° 11.33'S	169° 39.28'W
11	2/06/94	1630	78° 10.25'S	172° 00.12'W
13	2/07/94		78° 08.83'S	173° 31.24'W
15	2/07/94	0800	78° 07.08'S	174° 30.12'W
19	2/07/94	1405	78° 03.39'S	175° 32.08'W
21	2/07/94	1810	78° 04.25'S	176° 32.21'W
23	2/07/94	2320	78° 03.01'S	177° 30.29'W
25	2/08/94		77° 57.24'S	179° 00.39'W
27	2/08/94	1145	77° 52.74'S	179° 00.94'E
29	2/08/94	1800	77° 40.42'S	177° 40.59'E
31	2/08/94	2345	77° 25.60'S	176° 00.10'E
33	2/09/94		77° 14.11'S	173° 22.42'E
34	2/09/94	1115	77° 18.34'S	172° 44.97'E
36	2/09/94	1800	77° 07.94'S	170° 50.30'E
38	2/09/94	2145	77° 24.80'S	169° 33.94'E
40	2/10/94		77° 10.51'S	167° 46.81'E
42	2/10/94	1130	77° 10.74'S	167° 46.27'E

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

APPENDIX E

APPENDIX F