

**DF-91 CRUISE REPORT
SEDIMENT TRAP REDEPLOYMENT CRUISE,
ROSS SEA, ANTARCTICA
U.S.C.G.C. POLAR SEA
FEBRUARY 8 - 16, 1991**

by

DAVID A. MUCCIARONE

Cruise Participants: David A. Mucciarone (S-216), John C. Moser (S-216), Geoffery Pierson (S-268), J. David Lucyk (S-268), and Livio Labbrozzi (S-268)

Five scientists representing S-216 and S-268 departed for McMurdo Station, Antarctica on 31 Jan 1991 and arrived on the same date at approximately 0915. Just over 5 days were spent in McMurdo preparing for the cruise, 8 days on the USCGC Polar Sea, and the remaining 6 to 7 days spent on clean up in McMurdo and waiting for an available north bound LC-130.

The cruise for the most part was successful. We were able to locate all three mooring sites, however, only two sites (A and B) were recovered and redeployed. Site C was located but was not recovered due to either faulty releases and/or insufficient battery voltage to drive the release motors. Much time was spent triangulating on mooring C to obtain an accurate fix so that a dragging operation can be performed next year with a better equipped research vessel.

Twenty-six Niskin hydrocasts were taken at thirteen stations located on and in between the three mooring sites at 0 and 5 meters water depth. These samples were collected for POC ¹³C and Total CO₂ ¹³C analyses. In addition, we collected a total of 24 dissolution experiments, 12 (3 silica and 9 carbonate) each from Mooring A and B.

We also had some time before the cruise to sound to the McMurdo Sound W/O Mooring. The slant range was 863m at latitude 77° 47.7'S longitude 165° 59.3' E. The release was rearmed. The command codes for the release are: Enable=CDE, Release=ABEG, Rearm=CDEH.

The cruise schedule went as follows:

- Station 1: Arrive at Site A at 1930 on 2/8/91 - Mooring A recovery.
Depart on 2/9/91 at 0140. Repair mooring hardware during transit to Site B.
- Station 2: Hydrocast 0 and 5 meters 0415 on 2/9/91.
- Station 3: Hydrocast 0 and 5 meters 0808 on 2/9/91.
- Station 4: Hydrocast 0 and 5 meters 1219 on 2/9/91.
- Station 5: Hydrocast 0 and 5 meters 1629 on 2/9/91.
- Station 6: Arrive at Site B at 1845 on 2/9/91 - Mooring B recovery.
Mooring B deployment at 0850 on 2/11/91.
Hydrocast 0 and 5 meters 1105 on 2/11/91.
Depart on 2/11/91 at 1115. Repair mooring hardware during transit to Site C.
- Station 7: Hydrocast 0 and 5 meters 1545 on 2/11/91.

Station 8: Hydrocast 0 and 5 meters 2110 on 2/11/91.
 Station 9: Hydrocast 0 and 5 meters 0240 on 2/12/91.
 Station 10: Arrive at Site C at 0910 on 2/12/91 - Mooring C location. Problems sounding to release, no recovery attempt due to rough seas and bad weather. Rearm release and begin transit to Granite Harbor to locate 1990 w/o mooring. Depart on 2/12/91 at 0950. Repair mooring hardware during transit.
 Station GH: Arrive at Granite Harbor 1220 on 2/13/91 - Attempt many sounding to release around icebergs, no response. Depart on 2/13/91 at 1600 for Site C.
 Station 10: Arrive at Site C at 1120 on 2/14/91 - Mooring C recovery attempt. Triangulation on Mooring C. Acoustic releases would not respond to release commands. Only one of the two releases were operational. No recovery.
 Hydrocast 0 and 5 meters 1840 on 2/14/91.
 Depart on 2/14/91 at 1850. Transit to Site A.
 Station 11: Hydrocast 0 and 5 meters 0230 on 2/15/91.
 Station 12: Hydrocast 0 and 5 meters 0800 on 2/15/91.
 Station 13: Hydrocast 0 and 5 meters 1315 on 2/15/91.
 Station 14: Arrive at Site A at 1846 on 2/15/91 - Mooring A deployment
 Hydrocast 0 and 5 meters 2021 on 2/15/91.
 Depart on 2/15/91 at 2025. Transit to Cape Byrd and arrive at McMurdo Station on 2/16/91 at 2100.

MOORING A (Station 1) FEBRUARY 8-9, 1991, RECOVERY

Recovery of Mooring A went well considering the limited working space and deck equipment. Two boats were used in the recovery process, a 25ft Motor Surf Boat (MSB) and a 17ft Zodiac. Approximately 1 hour was spent triangulating on the release. This was due to poor communication on the bridge which was eventually corrected. The release code was sent at 2135 on 2/8/91. The MSB was used to tow each float package with trap and current meter to the casting deck of the ship. The Zodiac was used for the close work, hooking up the various floats and traps to the CTD winch cable or crane hook. Dissolution experiment samples were cut from the mooring line, floats and current meters in the water. It was not possible to remove them from the traps, that task was performed on deck.

Recovery Schedule:	On station at	1930 (2/8/91)
	Zodiac in water at	2035
	MSB in water at	2050
	Release code sent at (800m)	2135
	First floats at surface at	2140
	Top floats in tow by MSB at	2145
	Second floats at surface at	2149
	Top float package on deck at	2315
	Top trap on deck at	2340
	Top current meter on deck at	2349
	Middle float package on deck at	2356
	Bottom trap on deck at	0004 (2/9/91)
	Bottom current meter on deck at	0011
	Bottom float on deck at	0014
	Release on deck at	0015 (2/9/91)

Release Command Codes:

CARRIE

Enable = **DEG**

Release = **ADFG**

Rearm = **DEGH**

PAUL

Enable = **DEF**

Release = **ACEH**

Rearm = **DEGH**

Dissolution Experiment Samples: C19, C20, C21, C22, C23, C24, C25, C26, C27, and S1, S2, S3

The overall condition of the mooring was good. Both float packages were intact upon recovery, but the bottom set of 6 were damaged on deck. The nylon netting did an excellent job securing the float packages. As for the traps, they performed as expected. A math overflow error stopped the traps rotation on 3/17/90. Therefore, only three tubes out of fifteen were collected from each trap. The spring mechanism on the top trap was broken and the spring shaft on the bottom was fractured but still holding tension.

Microprocessor programming: **See** attached outline for the sediment trap set-up procedure

Recovery Filenames: A-FEB90R.TOP and A-FEB90R.BOT

Program Error: HOW ERROR #9
490 ? = ? + w * 100?
Error date 3/17/91 - trap stopped

Battery Condition: 1.18 & 1.88 volts (Micro 9v alkaline, 1/ea)
2.99 volts/each (RAM 3v lithium, 1/ea)
8.78 volts/each (Motor 9v alkaline, 4/ea)

Acoustic Releases:

Battery Condition: CARRIE & PAUL (InterOcean 1090E)
3.65 volts/each (3.9v lithium D cells)
7.26 & 7.27 volts (3.9v lithium D cells, 2/ea in series)
7.25 & 7.28 volts (3.9v lithium D cells, 6/ea in series)

MOORING A (Station 14) FEBRUARY 15, 1991, DEPLOYMENT

Microprocessor programming: **See** attached outline for the sediment trap set-up procedure

Deployment Filename: C-ATOP.F91 and C-ABOT.F91

Battery Condition: 9.27 volts/each (9v alkaline, 7 total)
9.13 & 9.08 volts (Micro 9v alkaline, 3/ea in series)
3.01 & 3.00 volts (RAM 3v lithium, 1/ea)
18.39 & 18.36 volts (Motor 9v alkaline, 4/ea in series)

Program Schedule:

Cup 1	Timer begin on 2/13/91 at 09:12:35 (Top)		
	Timer begin on 2/13/91 at 08:58:15 (Bottom)		
Cup 2	7 days	Event 1	20 FEB 91
Cup 3	21	Event 2	06 MAR 91
Cup 4	42	Event 3	27 MAR 91
Cup 5	70	Event 4	24 APR 91
Cup 6	98	Event 5	22 MAY 91
Cup 7	140	Event 6	03 JUL 91

Cup 8	182	Event 7	14 AUG 91
Cup 9	224	Event 8	25 SEP 91
Cup 10	252	Event 9	23 OCT 91
Cup 11	280	Event 10	20 NOV 91
Cup 12	301	Event 11	11 DEC 91
Cup 13	322	Event 12	01 JAN 92
Cup 14	336	Event 13	15 JAN 92
Cup 15	350	Event 14	29 JAN 92

Mooring Line Specs: VLS Duron 3/8" Sampson Braid w/ 5/8" nylon thimbles

Single float to Package of 8 floats	15m
Package of 8 floats to top trap	25m*
Top trap to top current meter	10m
Top current meter to package of 6 floats	375m
Package of 6 floats to Bottom trap	80m + 25m*
Bottom trap to bottom current meter	10m
Bottom current meter to bottom float	25m
Bottom float to single release	5m
Single release to anchor weight (1600lbs)	3m

*Length of trap pendant 9/16" 2in 1 Sampson Braid

Metal Hardware Specs:

- Chain - 1/2" high-test galvanize, 3m long
- Sling - 1/2" stainless steal, 8ft long w/ 1ft long x 4" wide flemished & mechanically spliced loops on each end.
- Shackles - 1/2" galvanize w/ 5/8" pin (N=2)
- Shackles - 16mm stainless steal (N= 9)
- Master link - Not required for single release

Note: See attached mooring diagram for orientation.

Spring Rotations: 3.5 turns each

Acoustic Releases:

Battery Condition: DAVE (InterOcean 1090E)

- 3.94 volts/each (3.9v lithium D cells, 8 total)
- 7.89 volts (3.9v lithium D cells, 2/ea in series)
- 7.88 volts (3.9v lithium D cells, 6/ea in series)

Battery type: Electrochem Industries
Series: BCX 72, Size = 3B75

Cup Poisoning Solution: 10% Buffered Na-borate solution of formalin with filtered seawater

Deployment Schedule:

MSB in water at	1839 (2/15/91)
Top floats in water at	1900
Top floats in tow by MSB at	1904
Top trap in water at	1910
Top current meter in water at	1913
Middle float package in water at	1930
Bottom trap in water at	1949
Bottom current meter in water at	1956
Bottom float in water at	2004
Release in water at	2004

Anchor weight in water at 2006 (2/15/91)

Mooring A Location:
Latitude - 76° 31.29'S
Longitude - 167° 25.10'E
Water Depth - 786m (Release 780m)
Date & Time - 15 February 1991 at 2006

Release Command Codes: DAVE
Enable = **BEF**
Release = **ABFH**
Rearm = **BEFH**

The mooring deployment went well. We used the MSB during the deployment to tow the top of the mooring array away from the casting deck on the port side of the Polar Sea. The top 8 floats, 4 in nylon netting (original top set) and 4 on chain. Bottom 6 floats all on chain. All of the hardhats on the Benthos floats bolted to chain were in very good condition and flexible. See the attached Maneuvering Board Plot for the placement of Mooring A.

MOORING B (Station 6) FEBRUARY 11, 1991, RECOVERY

Recovery of Mooring B went much better than Mooring A. There were no problems locating the site because the ship stopped almost on top of the mooring. Again two boats were used in the recovery process, a 25ft Motor Surf Boat (MSB) and a 17ft Zodiac. The release code was sent at 1911 on 2/9/91, this was approximately 10 minutes after the launch of the MSB. As with the first recovery the MSB was used to tow each float package with trap and current meter to the casting deck of the ship. The Zodiac was used for the close work, hooking up the various floats and traps to the CTD winch cable or crane hook. Dissolution experiment samples were cut from the mooring line, floats and current meters in the water. It was not possible to remove them from the traps, that task was performed on deck.

Recovery Schedule:

On station at	1846 (2/8/91)
MSB in water at	1902
Release code sent at (556m)	1911
First floats at surface	1916
Second floats at surface	1922
Top floats in tow by MSB at	1923
Zodiac in water at	1925
Top float package on deck at	2000
Top trap on deck at	2024
Top current meter on deck at	2031
Middle float package on deck at	2125
Bottom trap on deck at	2144
Bottom current meter on deck at	2151
Bottom float on deck at	2152
Release on deck at	2154 (2/8/91)

Release Command Codes: DAVE
Enable = **BEF**
Release = **ABFH**
Rearm = **BEFH**

Dissolution Experiment Samples: C1, C2, C3, C4, C5, C6, C7, C8, C9, and

S1, S2, S3

The overall condition of the mooring was good. Both float packages were intact upon recovery, but the bottom set of 6 were damaged on deck. The nylon netting did an excellent job securing the float packages. As for the traps, they performed as expected. A math overflow error stopped the traps rotation on 3/19/90. Therefore, only three tubes out of fifteen were collected. The spring mechanism on the bottom trap was broken and the spring shaft on the top had small stress fractures.

Microprocessor programming: **See** attached outline for the sediment trap set-up procedure

Recovery Filename: B-FEB90R.TOP and B-FEB90R.BOT

Program Error: HOW ERROR #9 (Math overflow)
490 ? = ? + w * 100?
Error date 3/17/91 - trap stopped

Battery Condition: 2.12 & 1.72 volts (Micro 9v alkaline, 1/ea)
3.01 & 3.00 volts/each (RAM 3v lithium, 1/ea)
8.78 volts/each (Motor 9v alkaline, 4/ea)

Acoustic Releases:

Battery Condition: DAVE (InterOcean 1090E)
3.65 volts/each (3.9v lithium D cells)
7.30 volts (3.9v lithium D cells, 2/ea in series)
7.29 volts (3.9v lithium D cells, 6/ea in series)

MOORING B (Station 6) FEBRUARY 11, 1991, DEPLOYMENT

Microprocessor programming: **See** attached outline for the sediment trap set-up procedure

Deployment Filename: BT3.F91 and BB3.F91

Battery Condition: 9.08 & 9.15 volts (Micro 9v alkaline, 3/ea in series)
3.21 & 3.29 volts (RAM 3v lithium, 1/ea)
18.34 & 18.40 volts (Motor 9v alkaline, 4/ea in series)

Program Schedule:

Cup 1	Timer begin on 2/11/91 at 09:02:26 (Top)		
	Timer begin on 2/11/91 at 08:46:19 (Bottom)		
Cup 2	9 days	Event 1	20 FEB 91
Cup 3	23	Event 2	06 MAR 91
Cup 4	44	Event 3	27 MAR 91
Cup 5	72	Event 4	24 APR 91
Cup 6	100	Event 5	22 MAY 91
Cup 7	142	Event 6	03 JUL 91
Cup 8	184	Event 7	14 AUG 91
Cup 9	226	Event 8	25 SEP 91
Cup 10	254	Event 9	23 OCT 91
Cup 11	282	Event 10	20 NOV 91
Cup 12	303	Event 11	11 DEC 91
Cup 13	324	Event 12	01 JAN 92
Cup 14	338	Event 13	15 JAN 92

Deployment Schedule:	MSB in water at	0840 (2/11/91)
	Top floats in water at	0854
	Top floats in tow by MSB at	0857
	Top trap in water at	0905
	Top current meter in water at	0910
	Middle float package in water at	0930
	Bottom trap in water at	0958
	Bottom current meter in water at	1005
	Bottom float in water at	1006
	Release in water at	1010
	Anchor weight in water at	1019 (2/11/91)

Mooring B Location:

Latitude - 76° 31.203'S
Longitude - 175° 00.976'W
Water Depth - 575m (Release 570m)
Date & Time- 11 February 1991 at 1019

Release Command Codes:	<u>CARRIE</u>	<u>PAUL</u>
	Enable = DEG	Enable = DEF
	Release = ADFG	Release = ACEH
	Rearm = DEGH	Rearm = DEGH

The mooring deployment went well. We used the MSB during the deployment to tow the top of the mooring array away from the casting deck on the port side of the Polar Sea. The bottom 2 floats from the package of 6 and bottom 4 floats from the package of 8 from Mooring A were combined to make a package of 6 for Mooring B.

MOORING C (Station 10) FEBRUARY 14, 1991, RECOVERY ATTEMPT

Recovery of Mooring C did not go very well. Our first attempt to recover the mooring was terminated due to rough seas (10-12ft) and bad weather (wind 30kt and snow) on 12 February. We made a couple of attempts to range to the release with the command unit, but there was no response from release MARIAN. The weather guessers predicted this storm to last approximately 24 to 36 hours, so instead of waiting around at Site C we decided to transit to Granite Harbor and try to locate the 1990 winterover mooring. Unfortunately, we were unable to locate the mooring after many attempts sounding around icebergs so after about 5 to 6 hours we headed back to Site C to attempt a recovery. When we arrived at Site C on 2/14/91, at 1120 we located the mooring, but it was difficult. The ranges received by the command unit were inconsistent. Very large ranges were received at first (e.g., 2500m), then 3 to 4 consistent ranges (e.g., 875, 879, 881, 883), then a couple of odd ranges with an occasional OVER return. At 1207 the MSB was launched so we could triangulate on the mooring. This turned out to be a difficult task because the release would not give consistent returns. For about three and a half hours the release code was sent, however, there was no response (standard 2 pings/second). After sending the release code the ranges received would be OVER, OVER, OVER, a large range (e.g., 1300m), then consistent ranges (e.g., 525, 527, 528, ...). This routine was repeated at least a dozen or more times, the same pattern was observed. It was as if the batteries would drain low after the release code transmission and then slowly recover enough to give a range. All of this was done with only one (MARIAN) of the two (RICHARD) releases. The other release RICHARD would not respond at all.

After carefully triangulating on the mooring we obtained a slant range of 522m and a very accurate GPS fix. See the attached Maneuvering Board Plot for the placement of Mooring C. We gave some thought of dragging for the mooring, but after much debate we decided not to for the following reasons:

- 1) Hydrowinch had 7 fairleads to the J-frame and had a tendency to jam or jump a pulley or two.

2) Hydrowire/CTD cable was too short (<2500m), which would have made dragging difficult, and too smooth. It took 160m of constant rubbing in one spot to cut the VLS Duron rope so cutting the line was out. Besides the cable probably would end up rubbing on either metal bar or a piece of equipment and not the rope. Even if we did cut the line, we would not get all of the mooring back, especially the release, to make a redeployment.

3) We were able to obtain an accurate fix to attempt a recovery with a better equipped vessel.

4) The Coast Guard crew had never attempted such an operation, and the mobility of the Polar Sea was not good enough with the short CTD cable

Recovery Schedule:	On station at	1120 (2/14/91)
	MSB in water at	1207
	Release code sent at (522m)	1248 - 1615
	No release/no recovery	
	Terminate recovery operation at	1630 (2/14/91)

Mooring C Location:	Latitude -	72° 28.8'S
	Longitude -	172° 31.6'E
	Water Depth -	522m (Release 517m)
	Date & Time-	14 February 1991 at 1630

Release Command Codes:	<u>MARIAN</u>	<u>RICHARD</u>
	Enable = CEF	Enable = BFG
	Release = ABDF	Release = ADFH
	Rearm = CEFG	Rearm = BFGH

Dissolution Experiment Samples: C10, C11, C12, C13, C14, C15, C16, C17, C18, and
(Not recovered) S1, S2, S3

If these traps worked as expected (Math overflow error observed on Moorings A and B), only six sample cups were used per trap. That is if the spring mechanisms in the traps did not fail prior to the software error (on 3/17/91).

GRANITE HARBOR MOORING (Station GH), FEBRUARY 13, 1991, LOCATION ATTEMPT

We were unsuccessful in locating the mooring in Granite Harbor/Avalanche Bay. Many soundings were made around the icebergs in the area. There was no response from the acoustic release (TONY). See the attached map that illustrates the surveyed area.

Release Command Codes:	<u>TONY</u>
	Enable = CDF
	Release = ABCG
	Rearm = CDFG

DISSOLUTION EXPERIMENTS (Stations 1 and 6), Moorings A and B

All carbonate and silica dissolution experiment samples (N=24) from Mooring A and B were collected. Since Mooring C was not recovered, these samples were obviously not collected. All samples were gently rinsed with distilled water in Nalgene containers and allowed to air dry (there was no oven on board the ship). In essence, the procedure outlined by Charles Hart and Any Leventer was followed (See attached letter from Ohio State).

HYDROCAST SAMPLES (Stations 2 through 14)

Twenty-six (26) 25ml water samples and filtered samples were collected at 13 stations on Sites A,B and C, as well as in between each site. These samples were taken at 0 and 5m using a 5l Niskin bottle. The samples collected are for POC ¹³C and Total CO₂ ¹³C analyses. The water samples for Total CO₂ were sealed in 25ml ampules immediately after collection. All of the samples for POC were filtered through 21mm GFC filters and air dried. The amount of water filtered ranges from 650ml to 2000ml. See table below for specific details on hydrocasts.

Table: Site locations of all hydrocasts taken on cruise. The volume listed below is the amount of water filtered.

Stn. (Site)	Hydrocast Depth		Sample	Latitude	Longitude	Time	Date
	0 meters	5 meters					
2	1000ml	1000ml	A/F*	76° 29.5'S	170° 51.2'E	0415	2/09/91
3	1000ml	1000ml	A/F	76° 29.4'S	174° 30.4'E	0808	2/09/91
4	1000ml	2000ml	A/F	76° 29.5'S	178° 10.9'E	1219	2/09/91
5	500ml	500ml	A/F	76° 30.3'S	178° 16.1'W	1629	2/09/91
6 (B)	650ml	650ml	A/F	76° 31.3'S	175° 01.8'W	1105	2/11/91
7	1000ml	1000ml	A/F	75° 35.0'S	178° 12.0'W	1545	2/11/91
8	1000ml	1000ml	A/F	74° 39.1'S	178° 48.4'E	2110	2/11/91
9	500ml	500ml	A/F	73° 37.3'S	175° 48.6'E	0240	2/12/91
10 (C)	1000ml	1000ml	A/F	72° 31.9'S	172° 30.7'E	1840	2/14/91
11	650ml	650ml	A/F	73° 34.2'S	171° 13.8'E	0230	2/15/91
12	750ml	750ml	A/F	74° 37.1'S	169° 50.9'E	0800	2/15/91
13	650ml	650ml	A/F	75° 35.3'S	168° 36.1'E	1315	2/15/91
14 (A)	550ml	500ml	A/F	76° 31.3'S	167° 25.1'E	2021	2/15/91

Note: * A = 25ml ampule; F = 21mm GFC filter