WHOI-2001-12

Woods Hole Oceanographic Institution

Preliminary Acoustic and Oceanographic Observations from the ASIAEX 2001 South China Sea Experiment

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Technical Report

Funding was provided by the Office of Naval Research under Grant Numbers N00014-01-1-0772, N00014-98-1-0413 and N00014-00-1-0206.

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Approved for Distribution:

W Rockwell Geyer

W. Rockwell Geyer, Chair

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1.0 Introduction

The Asian Seas International Experiment (ASIAEX) was a very successful scientific collaboration between the United States of America (USA), the People's Republic of China (PRC), Taiwan (ROC), the Republic of Korea (ROK), Japan, Russia, and Singapore. Preliminary field experiments associated with ASIAEX began in spring of 2000. The main experiments were performed in April-August, 2001. The scientific plan called for two major acoustics experiments, the first a bottom interaction experiment in the East China Sea (ECS) and the second a volume interaction experiment in the South China Sea (SCS). In addition to the acoustics efforts, there were also extremely strong physical oceanography and geology and geophysics components to the experiments. This report will concentrate on describing the moored component of the South China Sea portion of ASIAEX 2001 performed from the Taiwan Fisheries research vessel *FR1* (Fisheries Researcher 1). Information on the environmental moorings deployed from the Taiwanese oceanographic research vessel *OR1* (Oceanographic Researcher 1) will also be listed here for completeness, so that the reader can pursue later analyses of the data. This report does not pursue any data analyses per se.

The venue for the 2001 South China Sea component of ASIAEX is shown in the two panels of Figure 1, which include 12-km resolution bathymetry. The top panel shows the geographic location of the experiment, near the shelf edge to the southeast of Hong Kong, PRC. The lower panel shows the location of the moored sensors deployed and recovered in the experiment, as well as the SeaSoar hydrography tracks which will be the topic of another report. Eight moorings which were not recovered are not shown.

The deployment/recovery timeline for the moored instruments in the SCS is shown in Figure 2. The first timeline in that figure is for the core instrument deployed in the SCS, the WHOI/NPS horizontal/vertical acoustic array, which monitored transmissions from both moored and towed acoustic sources over a sixteen day period. This period encompassed a full spring-neap tidal cycle. The next five timelines are those of the moored sources that were deployed at the site. These sources were set before the array was deployed, and recovered after the array's recovery, which means that they were heard by the array over the full sixteen days of array operation. The J-15-3 source was a towed acoustic source which put out a variety of waveforms in the 50-600 Hz range during five separate tow runs. The J-15-3 transmitted frequencies which were complementary to those employed by the moored sources, so that interference would not occur. The light bulb drops refer to ordinary electric light bulbs that were weighted and dropped in the water to create implosions in the vicinity of the receiving array. These implosions were used to locate the positions of the horizontal array elements, as will be discussed in detail later. The T-string at the sources refers to a vertical thermistor chain deployed near the shallower (~120m) acoustic sources (see Figure 1). This string was used to provide soundspeed time series while the sources were in operation. The deep T-string refers to the easternmost T-string, deployed in ~140m water. This T-string was, in effect, an extra mooring, and so we deployed it to the east of the main experimental site in order to get some information in a relatively undersampled location. The SeaSoar timeline is for the deep (tracks not shown in Figure 1) and shallow (tracks shown in Figure 1) SeaSoar operations. Rather distressingly, shallow SeaSoar tracks, which purposely covered the acoustic propagation paths, were terminated early on May 11th due to a nearby typhoon. Thus the amount of SeaSoar coverage of the acoustics experiment was less than was originally planned. The final time-line is for generic environmental data which includes ADCP and locomoor moorings, meteorology, sea states, and other such data. These were generally collected during the whole experimental period.

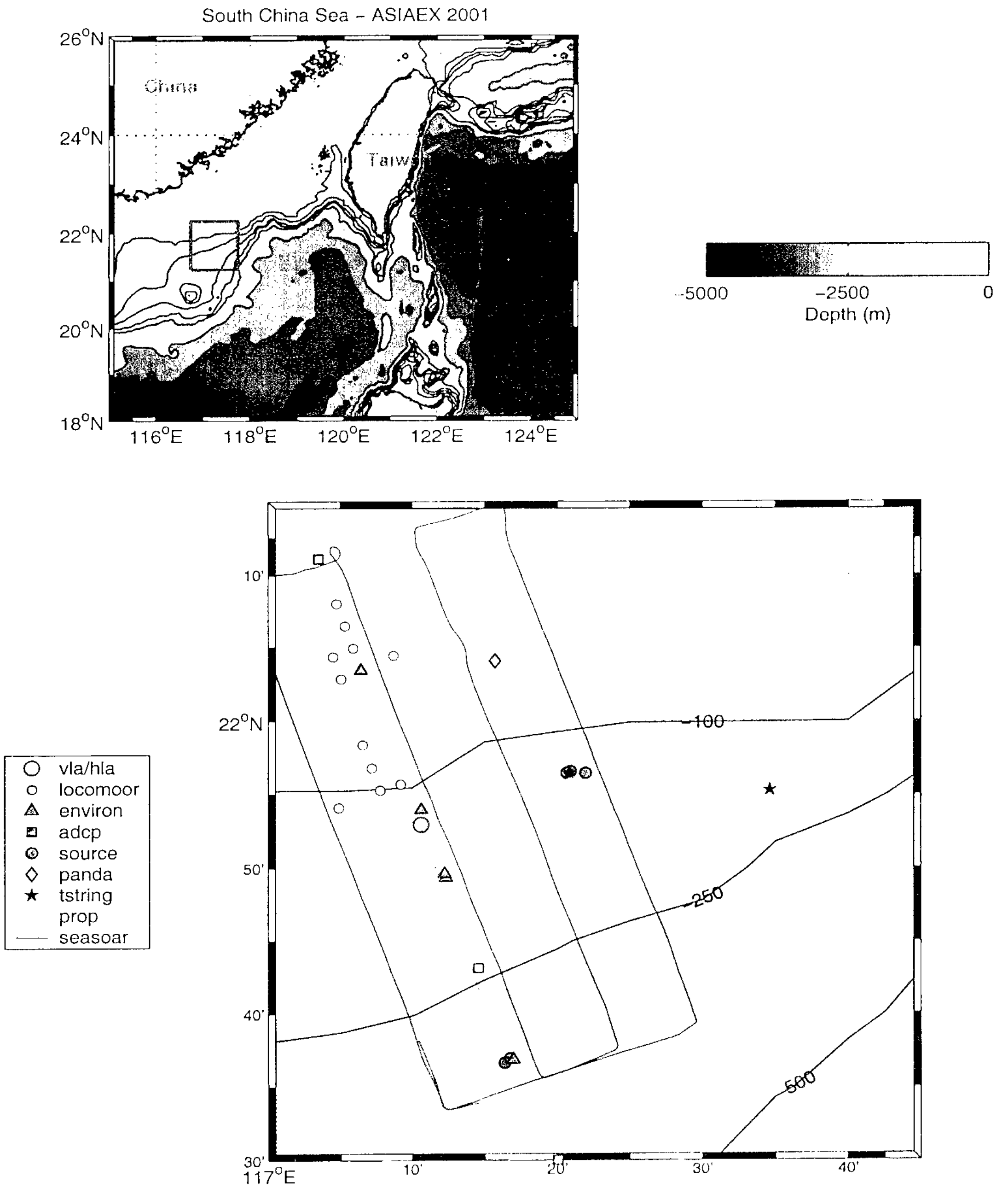

FIGURE 1. ASIAEX 2001 South China Sea area of study and mooring locations.

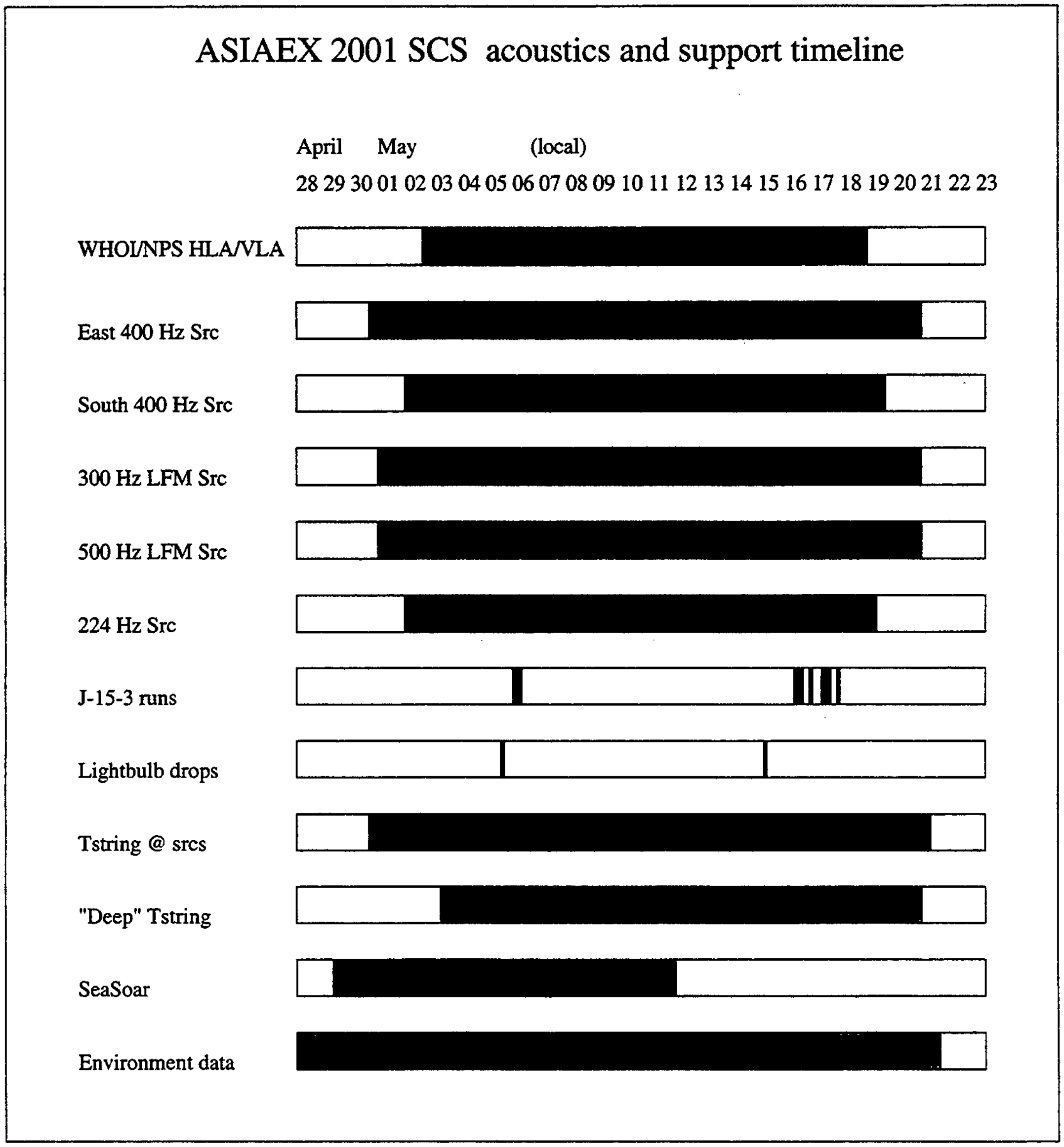

FIGURE 2. ASIAEX 2001 acoustics and direct acoustics support timeline. The environmental moorings were deployed from the *OR1* prior to April 28.

2.0 Personnel

The ASIAEX 2001 South China Sea experiment was a joint, international venture that included many research institutions and investigators. Table 1 lists the principal investigators of the many projects. Table 2 lists the personnel aboard the *FR1* who were responsible for the equipment and data taken for this report. Table 3 lists the collaborating institutions.

TABLE 1. ASIAEX 2001 South China Sea Principal Investigators.

name	Institution	Responsibilities
Mike Caruso	WHOI	Remote sensing, SST
Eng-Soon Chan	NUS	Towed CTD
Chi Fang Chen	NTU	Volume Interaction
Ching Sang Chiu	NPS	Acoustic moorings, Associate International Science Coordinator
Wen-Hwa Chuang	NTU	Physical Oceanography
Tim Duda	WHOI	Loco moorings
Glen Gawarkiewicz	WHOI	SeaSoar
John Kemp	WHOI	Logistics coordinator
Tony Liu	NGSFC	Remote sensing, SAR
Jim Lynch	WHOI	Acoustics moorings
Marshall Orr	NRL	Underway acoustics
Neal Pettigrew	UM	ADCP moorings
John Potter	NUS	PANDA moorings
Steve Ramp	NPS	Environment moorings, International Science Coordinator
Steve Schock	FAU	Chirp sonar
David Tang	NTU	Environment moorings
Chau Chang Wang	NSYSU	Towed CTD
Joe Wang	NTU	SeaSoar
Ruey-Chang Wei	NSYSU	Kaohsiung Logistics Coordinator
Steve Wolf	NRL	Underway acoustics
Ying-Jang Yang	CNA	Environmental Moorings

TABLE 2. ASIAEX South China Sea *FR1* personnel.

Name	Institution	Responsibilities
Earl Carey	NRL	SGAM engineer
Lawrence Costello	WHOI	Mooring operations
Wen-Hwa Chuang	NTU	Mooring operations
Geoff Ekblaw	WHOI	Welding and fabrications
Craig Johnson	WHOI	Welding and fabrication
John Kemp	WHOI	Logistics and mooring ops PI
Steve Liberatore	WHOI	Acoustic source engineer
Wei-Lee Lu	CNA	Observer
Jim Lynch	WHOI	Acoustics PI
Neil McPhee	WHOI	Mooring operations
Chris Miller	NPS	Acoustic sources
Arthur Newhall	WHOI	Data and computers
Don Peters	WHOI	Design and fabrication
Jeff Schindall	NRL	SGAM Engineer
Steve Schock	FAU	Chirp sonar PI
David Tang	NTU	Oceanography PI
Keith Von der Heydt	WHOI	Shark HLA/VLA engineer
Jim Wulf	FAU	Chirp sonar engineer

TABLE 3. South China Sea institution acronyms.

Acronym	Institution
CNA	Chinese Naval Academy (Kaohsiung)
FAU	Florida Atlantic University
NGSFC	NASA Goddard Space Flight Center
NPS	Naval Postgraduate School
NRL	Naval Research Lab
NSYSU	National Sun Yat-sen University
NTU	National Taiwan University
NUS	National University of Singapore
UM	University of Maine
WHOI	Woods Hole Oceanographic Institution

3.0 Acoustics group instrumentation

The Taiwanese Fisheries Research vessel *FR1* was not originally equipped to perform physical oceanographic or acoustic mooring operations, so the entire deck had to be modified with metal plating, blocks, and eyebolts. The largest of these modifications was the construction of a flat platform above the stern ramp. All new components were welded onto the decking of the *FR1*. The added components were removed after completion of the experiment, thus returning the ship to its original configuration.

FIGURE 3. *FR1* deck, ready for deployment.

The *FR1* was the largest of the 3 vessels employed during ASIAEX01. She was selected for the acoustics operations which required the handling of heavy mooring equipment. The science plan for the *FR1* was to deploy 5 sources, 2 hydrophone VLA/HLA arrays, and 2 thermistor strings. During recovery operations, the *FR1* additionally picked up environment moorings, helping to speed up the recovery process.

3.0.1 *FR1* bridge GPS offsets

Because the Taiwanese vessels use older charts for navigation, they adjusted their GPS position to correspond to those charts. Thus, any positions recorded using the *FR1* GPS were subject to ~800m offset. These offsets, which were added to the WGS84 datum, are shown in Table 4. Thus, to calculate the true position (WGS84) that corresponds to the bridge GPS position latitude N and longitude E, subtract the latitude offset and add the longitude offset to the original bridge GPS position. For all instances that the *FR1* bridge

GPS positions were used, this report will indicate both the logged bridge GPS position and the true WGS84 position. So, for example, the WGS84 position 22 degrees North and 117 degrees East would be 22 degrees 0.092 minutes North and 116 degrees 59.521 minutes East according to the *FR1* bridge GPS.

TABLE 4. *FR1* GPS offsets in minutes.

Latitude	.092 N
Longitude	.479 W

3.0.2 *FR1* deployment depths and tidal amplitudes

At the moment a mooring was deployed, water column depth according to the *FR1* fathometer were recorded into a log. Depths were measured with a system that compensated for the depth of the hull-mounted transducer.

Some tide adjustment may be in order for high accuracy applications. According to our seafloor pressure records, tidal amplitudes for the South China Sea could be as large as approximately 1.5 meters, peak to peak.

3.0.3 Local time to UTC conversion

FR1 Log entries and some table entries are included here in local Taiwan time. The difference between Universal (UTC) time and Taiwan local time is 8 hours. To convert local time to UTC subtract 8 hours.

3.0.4 Typhoon and weather effects

All ships operations were temporarily halted on May 10th due to increased wind and swell created by a typhoon. The typhoon passed well to the east of our moorings on May 11th. The only ships performing ASIAEX01 operations at that time were the *OR1*, doing SeaSoar sampling and the SHARK (WHOI/NPS VLA/HLA) guard boat, Both vessels proceeded to shore. SeaSoar operations were permanently halted, whereas the guard boat returned when the seas subsided. None of the moorings were damaged by the typhoon.

Except at the time of the typhoon, the weather seldom changed. Conditions were generally hot and humid with little wind and no sea or swells. One exception was April 22nd, with 15-19 m/sec winds and high seas. Only *OR1* environmental mooring deployments were being carried out at this time.

3.1 Deep acoustic sources (southern, offshore)

A 224 Hz source and a 400 Hz source were deployed at the southern end of the off-shore propagation path (see figure 1). They were co-located to compare multiple frequency propagation along same path. Both moorings were located in deeper water (~350 meters) and were designed for minimum mooring motion due to tides and currents.

3.1.1 WHOI 224 Hz source

The WHOI 224 Hz source, affectionately nicknamed Bertha, is perhaps the oldest Webb Research Corporation (WRC) organ pipe tomography source still in operational use. It was first deployed in the 1981 tomography demonstration experiment in the Atlantic. A diagram of the "short tether" SCS 224 Hz mooring is shown in Figure 4. The deployment positions, times and depths for the source are given in Table 5. Because Bertha has an older, crystal oscillator clock, considerable clock drift was both expected and measured. Time checks before deployment and after recovery are shown in Table 6. Over the 18 day deployment, the system clock slowed by .058666 seconds. The source transmitted a 224 Hz phase encoded signal every 5 minutes starting on the hour. The detailed characteristics of the transmissions made by the 224 Hz source are shown in Table 7.

TABLE 5. 224 Hz Source "Bertha".

mooring/view number	6
deployed	5/01/01 1544 (local)
recovered	5/19/01 1025 (local)
latitude N (*FR1*)	21 36.662
lat.N Corrected	21 36.570
longitude E (*FR1*)	117 16.379
lon. E Corrected	117 16.858
water depth (log)	345.8 m
source depth	331.3 m (center of source)

TABLE 6. "Bertha" deployment and recovery time checks.

System time (UTC) **day hr min sec**	**GPS SAIL time (UTC)** **day hr min sec**
121 07 00 00	121 07 00 00.000008
139 05 15 00	139 05 15 00.058673

TABLE 7. "Bertha" transmission schedules.

start time (UTC)	day 121 (May 1) 08:00
Transmission period	every 5 minutes
center frequency (Hz)	224
bandwidth (Hz) - full 3dB	16
source level	183 dB re 1 uPa @ 1m
cycles per digit	14
digits per sequence	63
m-sequences per transmission	30
sequence length	3.9375 seconds
transmission time	118.125 seconds (30*3.9375)
M-sequence law	0103 (octal)

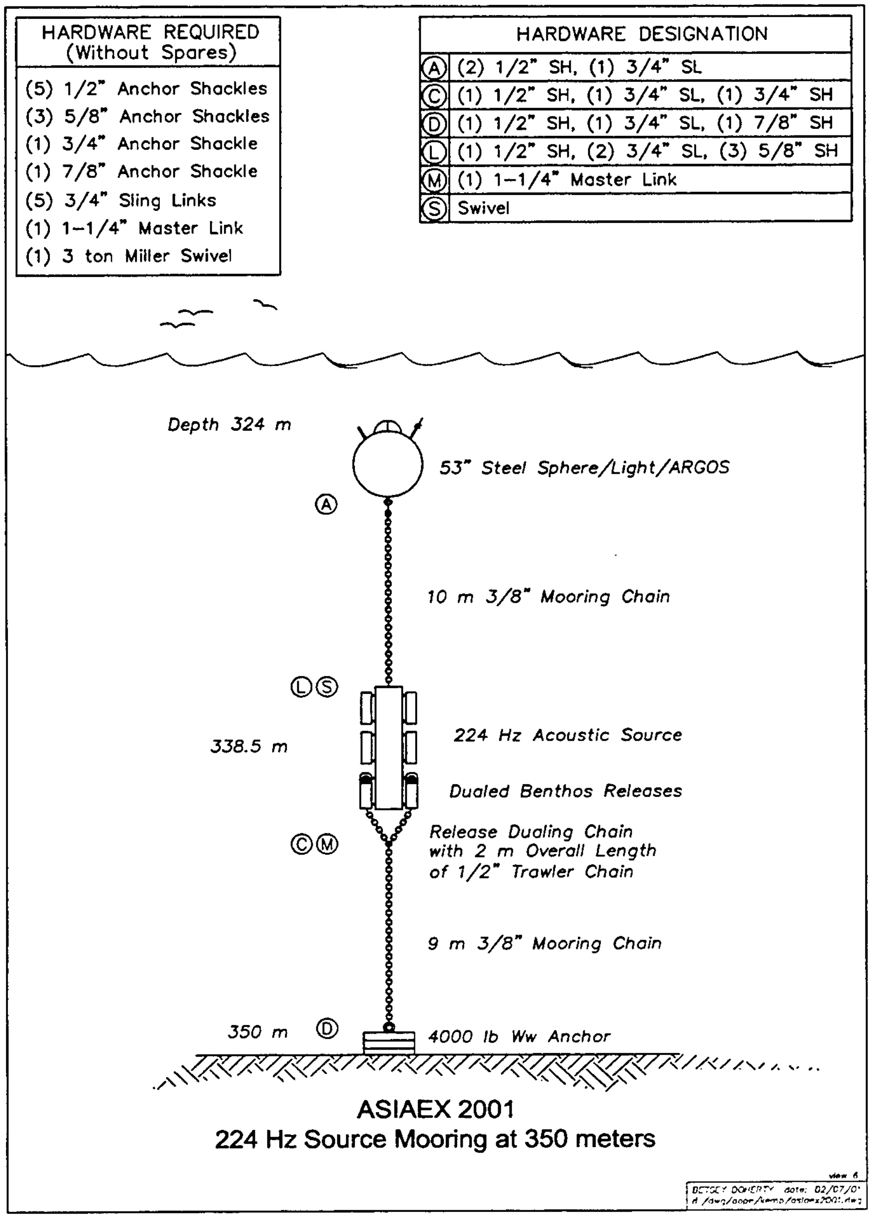

FIGURE 4. Mooring diagram for the 224 Hz source. Also referred to as mooring 6.

3.1.2 NPS 400 Hz source (deep position)

The second source located at the southern end of the cross-shelf fixed propagation path was a more modern 400 Hz WRC organ pipe source belonging to NPS. This source has a 100 Hz bandwidth. The mooring diagram for this source is shown in Figure 5. The deployment positions, times and depths for the source are given in Table 8. This source also had a crystal oscillator clock, the drifts for which are shown in Table 9. Over the 18 day deployment, the system clock for the deep 400 Hz source advanced by .050157 seconds. The transmission schedule for the deep 400 Hz source was programmed to change midway through the experiment, so as to enable examination of the details of internal wave induced acoustic fluctuations during the latter portion of the experiment. The source transmitted for ~7.5 minutes (449.68 seconds) every half hour for the first half of the experiment, then changed to transmitting every ~2 minutes (117.68 seconds) every ten minutes for the remaining half. The detailed characteristics of the two transmission schedules employed by the deep moored 400 Hz source are shown in Table 10 and Table 11.

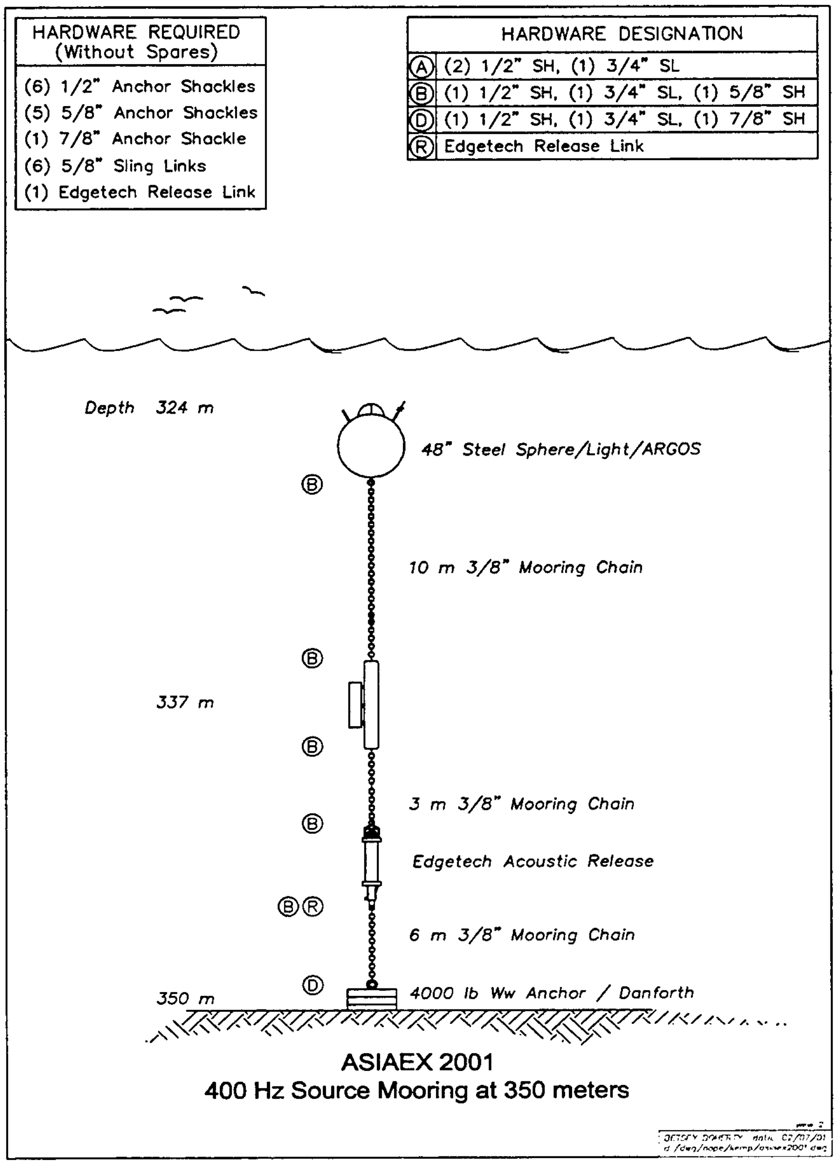

FIGURE 5. Configuration for NPS 400 Hz Source (deep mooring). Also called mooring #2.

TABLE 8. Deep 400 Hz Source.

system number	013
mooring/view number	2
deployed	05/01/01 1350 (local)
recovered	05/19/01 1050 (local)
latitude N (*FR1* GPS)	21 36.965
corrected lat. N	21 36.873
longitude E (*FR1*)	117 16.750
corrected long. E	117 17.229
water depth (log)	342.5 meters
source depth	329.5 meters (center of source)

TABLE 9. Deep 400 Hz source deployment and recovery time checks.

System time (UTC) **day hr min sec**	**GPS SAIL time (UTC)** **day hr min sec**
121 05 01 46	121 05 01 46.045512
139 03 37 13	139 03 37 12.995355

TABLE 10. Deep 400 Hz source transmission schedule - Task 1.

start time (UTC)	day 123 (May 3) 12:00:00
transmission times (minutes after the hour)	15,45
center frequency (Hz)	400
bandwidth (Hz) - full 3dB	100
source level	183 dB re 1 uPa @ 1m
cycles per digit	4
digits per sequence (sequence length)	511 (10 msec)
number of sequences transmitted	88 (449.68 seconds) (~7.5 minutes)
M-sequence law	1473 (octal)
sequence init.	000000001
modulation angle	87.467035

TABLE 11. Deep 400 Hz source transmission schedule - Task 2.

start time (UTC)	day 129 (May 9) 00:00:00
transmission times (minutes after the hour)	05,15,25,35,45,55
center frequency (Hz)	400
bandwidth (Hz)	100
source level	183 dB re 1 uPa @ 1m
cycles per digit	4
digits per sequence (sequence length)	511 (10 msec)
number of sequences transmitted	23 (117.53 seconds) (~2 minutes)
M-sequence law	1473 (octal)
sequence init.	000000001
modulation angle	87.467035

3.2 Shallow acoustic sources (eastern)

Three sources with different frequencies and transmission characteristics were deployed at the eastern end of the along-shore acoustics path: a WRC 400 Hz phase-encoded source, a WRC 300 Hz linear FM sweep source and a WRC 500 Hz linear FM sweep source.

3.2.1 NPS 400 Hz source (shallow position)

A WRC 400 Hz organ pipe source, similar to the 400 Hz source deployed at the southern end of the across-shelf acoustic propagation path, was placed at the end of the along-shelf path. The mooring diagram is shown in Figure 6. It too transmitted a phase encoded signal and, like the other 400 Hz source, the transmission scheme was programmed to change halfway through the experiment. It transmitted for ~7.5 minutes (449.68 secs) every 30 minutes for the first half of the experiment, then changed to transmit ~2 minutes (117.68 seconds) every 10 minutes for the remaining half. The initial deployment positions were logged using the *FR1* bridge GPS which included an offset to agree with their charts (see Table 4). The corrected deployment positions, times, and depths are shown in Table 12. This source also had a crystal oscillator. Clock checks are shown in Table 13. Over the 20 day deployment, the system clock for the shallow 400 Hz source slowed by .015995 seconds. The schedules for the source are given in Tables 14 and 15.

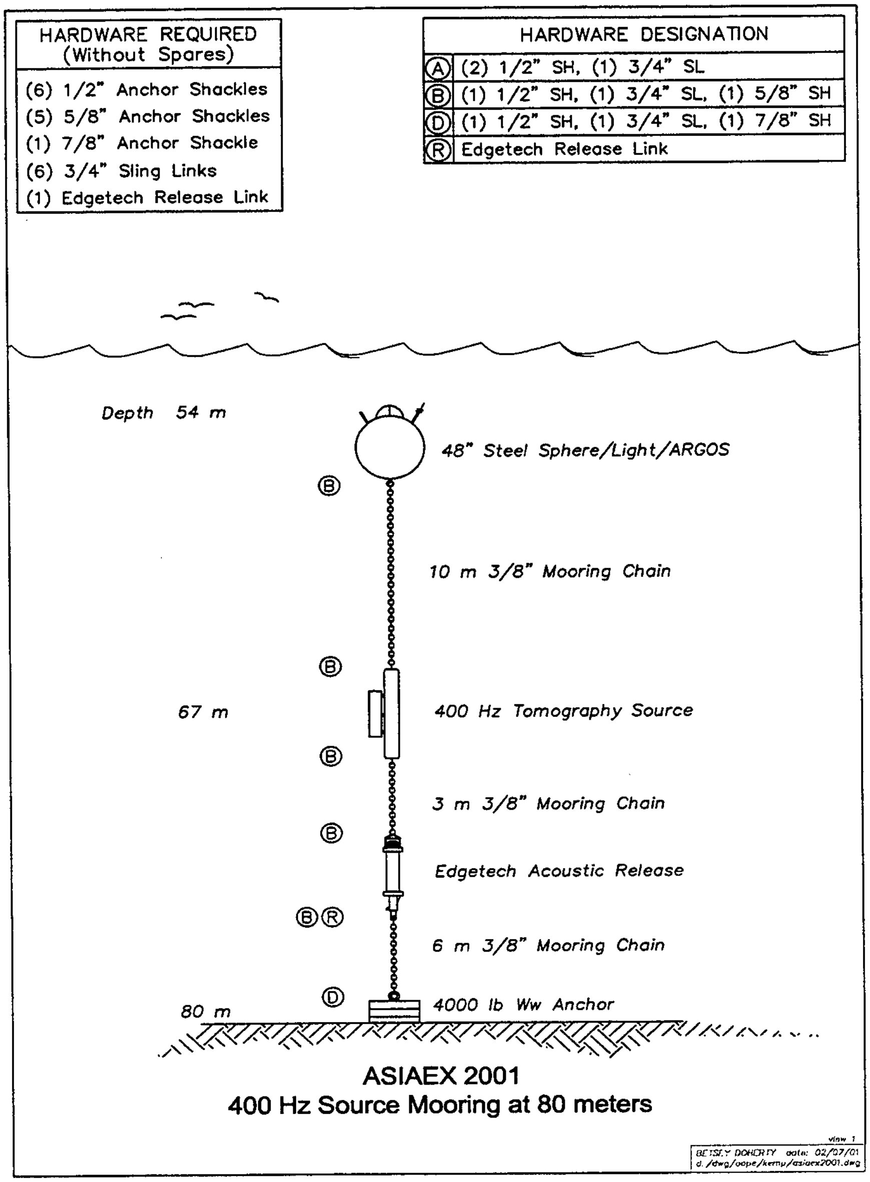

FIGURE 6. Mooring configuration of the 400 Hz source at eastern edge of the along-shelf propagation path. Also called mooring 1.

TABLE 12. Shallow 400 Hz Source.

system number	011
mooring/view number	3
deployed	04/30/01 0854 (local)
recovered	05/20/01 1000 (local)
latitude N (*FR1* GPS)	21 56.442
corrected lat. N	21 56.350
longitude E (*FR1*)	117 21.958
corrected long. E	117 21.437
water depth (log)	112.7 meters
source depth	99.7meters (center of source)

TABLE 13. Shallow 400 Hz source deployment and recovery time checks. This shows a slowdown of 16 msec over 20 days.

Source **System time (UTC)** **day hr min sec**	**GPS** **SAIL time (UTC)** **day hr min sec**
120 02 10 25	120 02 10 25.331766
140 02 36 21	140 02 36 21.315771

TABLE 14. Shallow 400 Hz source transmission schedule - Task 1.

start time (UTC)	day 122 (May 2) 12:00:00
transmission times (minutes after the hour)	0, 30
center frequency (Hz)	400
bandwidth (Hz) - full 3dB	100
source level	183 dB re 1 uPa @ 1m
cycles per digit	4
digits per sequence (sequence length)	511 (10 msec)
number of sequences transmitted	88 (449.68 seconds) (~7.5 minutes)
M-sequence law	1533 (octal)
sequence init.	000000001
modulation angle	87.467035

TABLE 15. Deep 400 Hz source transmission schedule - Task 2.

start time (UTC)	day 129 (May 9) 00:00:00
transmission times (minutes after the hour)	00, 10, 20, 30, 40, 50
center frequency (Hz)	400
bandwidth (Hz)	100
source level	183 dB re 1 uPa @ 1m
cycles per digit	4
digits per sequence (sequence length)	511 (10 msec)
number of sequences transmitted	23 (117.53 seconds) (~2 minutes)
M-sequence law	1473 (octal)
sequence init.	000000001
modulation angle	87.467035

3.2.2 NRL 300 Hz linear FM sweep source

The NRL 300 Hz source was also a WRC organ pipe source. Its deployment times, positions and depths are shown in Table 16. This newer Webb source emitted linear frequency modulated (LFM) signals, as opposed to the phase encoded sequences emitted by the older units. The source swept over 270-330 Hz in 2.048 seconds every 4 seconds, leaving a ~2 second gap between transmissions. It had a 0.2048 second (10% of transmission length) amplitude taper (between 0 and 100% power) at the beginning and end of each transmission to allow the graceful ramping on and off of the source. The 2.048 second period of the transmission was maintained to good accuracy by a crystal oscillator. However, the overall drift of the transmission time over the experiment and accurate absolute experimental beginning and ending times were not recorded, as these instruments were not intended to be used for travel time measurements. The characteristics of the source and its transmissions are found in Table 17. The mooring configuration is shown in Figure 7.

TABLE 16. NRL 300 Hz linear FM sweep source, mooring #3.

mooring/view number	1
deployed	04/30/01 1730 (local)
recovered	05/20/01 1259 (local)
latitude N (*FR1* GPS)	21 56.578
corrected lat. N	21 56.486
longitude E (*FR1* GPS)	117 20.909
corrected long. E	117 21.388
water depth (log)	114.3
source depth	102.3 (center of source)

TABLE 17. NRL 300 Hz linear FM sweep source transmission schedule.

transmission duration	2.048 seconds
taper duration	.2048 seconds (10%)
center frequency	300 Hz
sample frequency (Hz)	5000
bandwidth (Hz)	60
source level	183 dB re 1 uPa @ 1 m

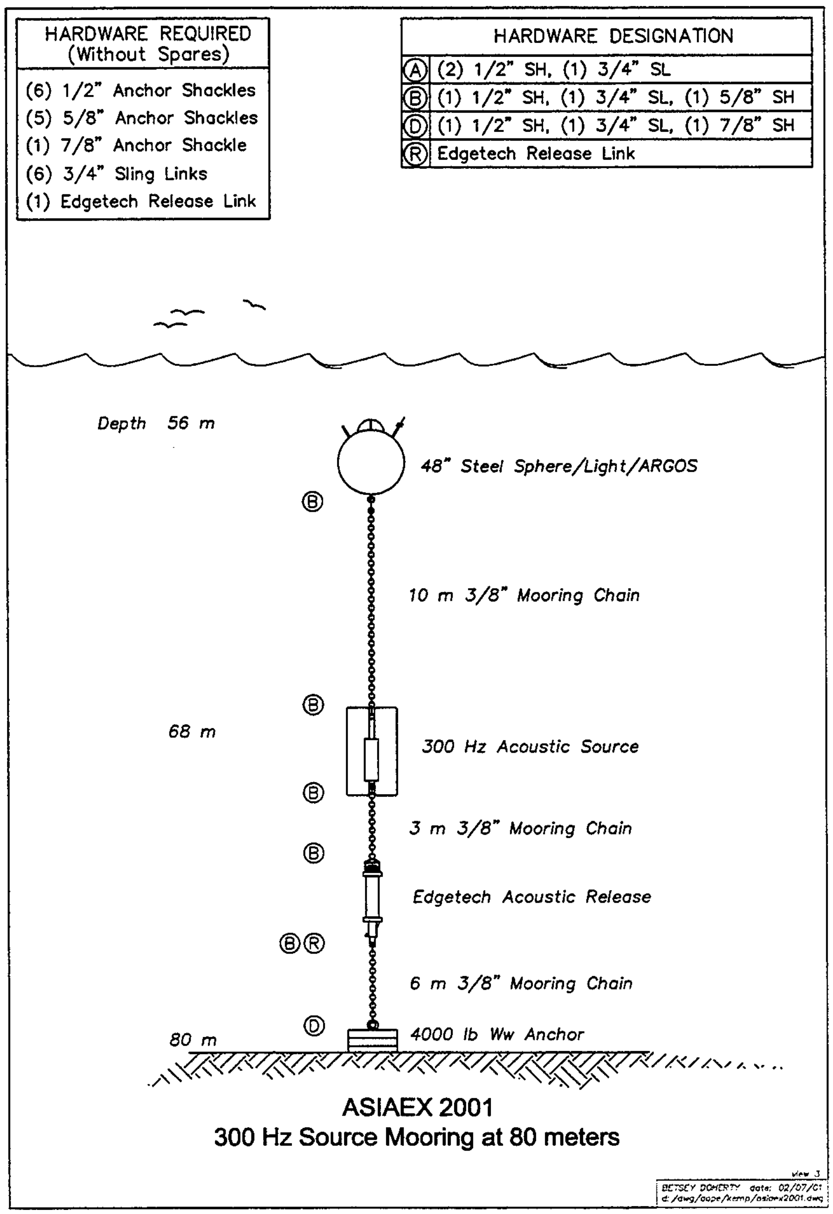

FIGURE 7. NRL 300 Hz FM sweep source mooring configuration (mooring 3). The sources were actually deployed in 117 meter deep water.

3.2.3 NRL 500 Hz linear FM sweep source

The configuration of the moored NRL 500 Hz source was very similar to that of the NRL 300 Hz source, with the only significant difference being the center frequency. The 500 Hz system deployment times, positions and depths are noted in Table 18. The characteristics of the source and its transmissions are found in Table 19. The mooring configuration is shown in Figure 8.

TABLE 18. NRL 500 Hz linear FM sweep source, mooring #4.

mooring/view number	4
deployed	04/30/01 1531 (local)
recovered	05/20/01 1125 (local)
latitude N (*FR1* GPS)	21 56.461
corrected lat. N	21 56.369
longitude E (*FR1* GPS)	117 20.656
corrected long. E	117 21.135
water depth	112.3
source depth	100.3 (center of source)

TABLE 19. NRL 500 Hz linear FM sweep source transmission schedule.

transmission duration	2.048 seconds
taper duration	.2048 seconds (10%)
center frequency (Hz)	500
sample frequency (Hz)	5000
bandwidth (Hz)	60
source level	183 dB re 1 uPa @ 1 m

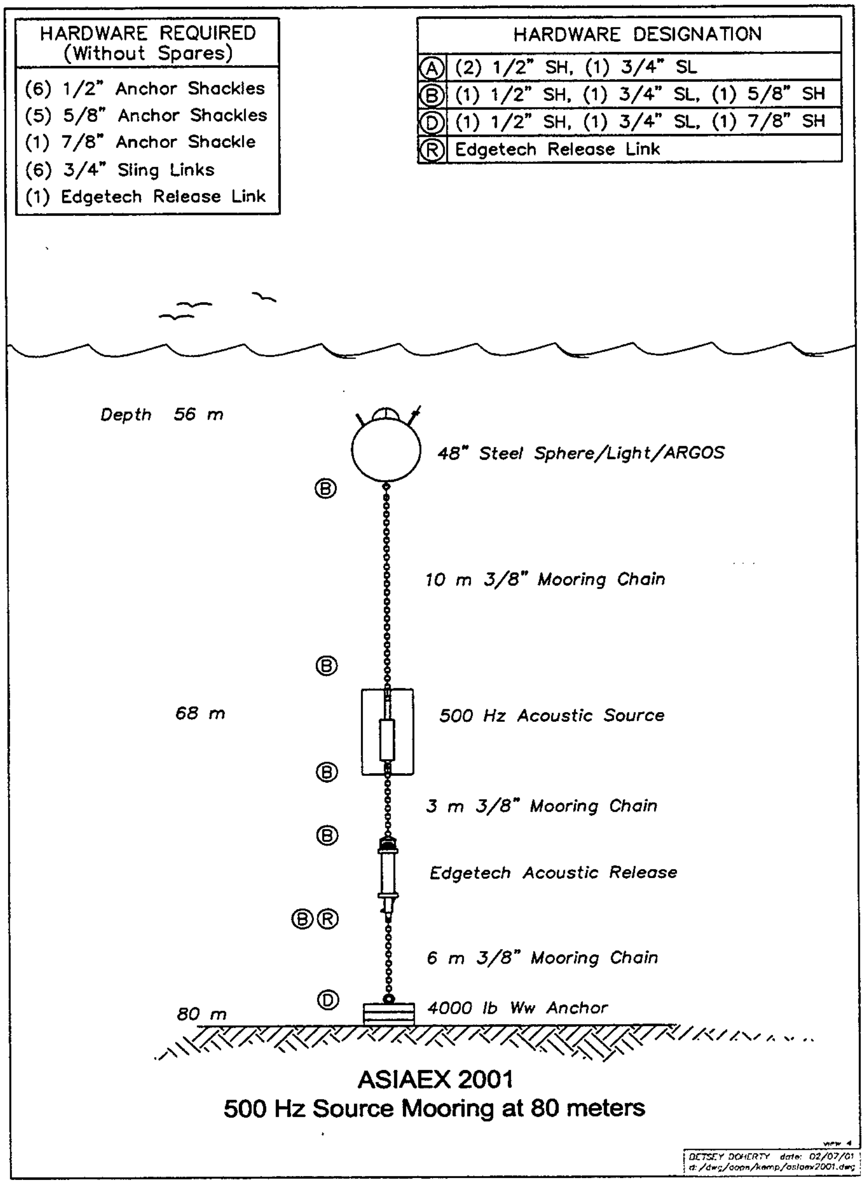

FIGURE 8. NRL 500 Hz linear FM sweep source mooring configuration (mooring 4). The source was actually deployed in 112 meters deep water.

3.3 Towed J-15-3 source (*OR3*)

NRL personnel aboard the R/V *OR3* periodically deployed and towed a J-15-3 broadband acoustic source. They employed a variety of tracks and waveforms to study transmission loss, matched field processing, array coherence, and other acoustic characteristics. The two main waveforms used were: CW tones and LFM sweeps. The CW transmissions were of 5 simultaneous tones: 140, 260, 340, 452, and 560 Hz. These frequencies were chosen to cover the band of interest and also not overlap the bands of the moored sources, which operated nearly continuously. The LFM sweeps also occupied the bandwidth in between the moored source bands, going from 50-600 Hz. As the *OR3*s portion of the SCS experiment will be reported upon separately by NRL personnel, we will refer the reader to their report for further detail. However, in order to understand the overall character of the acoustic receptions, which are part of this report, we give a brief synopsis of the J-15-3s operation times and waveform transmissions in Table 20.

TABLE 20. J-15-3 operation dates and times according to the *OR3* logbook.

start time (UTC)	end time (UTC)	transmission
05/05/01 12:15:50	05/05/01 23:29:30	5 tone CW
05/05/01 23:31:18	05/06/01 04:29:43	5 tone CW
05/16/01 00:08:26	05/16/01 09:10:28	LFM sweep
05/16/01 11:21:23	05/16/01 13:44:04	LFM sweep
05/17/01 05:03:10	05/17/01 11:05:15	LFM sweep
05/17/01 11:31:57	05/17/01 12:20:38	LFM sweep

3.4 Light bulb sources (*OR3*)

In order to obtain the exact positions of the array elements of the WHOI/NPS VLA/HLA, and also to verify the accuracy of the long baseline (LBL) localization system, NRL personnel deployed weighted and scored light bulbs at selected locations in the vicinity of the receiver array. These bulbs, when they imploded due to water pressure, created very useful broadband pulses. These were then used in a travel time triangulation formalism to locate the receiver array elements. These results will be discussed later in the report in section 5.0. In this section, we will only report the times and positions of the light bulb deployments. We note that, according to *OR3* log records, the light bulbs imploded about 40 seconds after launch, and that only about 50% of the light bulbs imploded. The launch times and positions are shown below in Table 21.

TABLE 21. Light bulb drop times and positions, from the *OR3* logbooks.

MM dd yy hhmm (UTC)	latitude N	Longitude E
05 05 2001 0816	21 52.443	117 10.772
05 05 2001 0819	21 52.431	117 10.753
05 05 2001 0821	21 52.415	117 10.740
05 05 2001 0823	21 52.398	117 10.731
05 05 2001 0825	21 52.375	117 10.718
05 05 2001 0828	21 52.341	117 10.694
05 05 2001 0830	21 52.319	117 10.678
05 05 2001 0832	21 52.293	117 10.661
05 05 2001 0834	21 52.276	117 10.645
05 05 2001 0836	21 52.260	117 10.631
05 05 2001 0838	21 52.240	117 10.617
05 05 2001 0840	21 52.219	117 10.602
05 05 2001 0917	21 53.117	117 10.634
05 05 2001 0920	21 53.092	117 10.626
05 05 2001 0922	21 53.073	117 10.605
05 05 2001 0923	21 53.062	117 10.595
05 05 2001 0924	21 53.053	117 10.586
05 05 2001 0925	21 53.041	117 10.574
05 05 2001 0926	21 53.030	117 10.564
05 05 2001 0927	21 53.018	117 10.553
05 05 2001 0931	21 52.979	117 10.511
05 05 2001 0933	21 52.970	117 10.491
05 15 2001 0100	21 52.450	117 10.458
05 15 2001 0102	21 52.418	117 10.420
05 15 2001 0104	21 52.377	117 10.380
05 15 2001 0106	21 52.337	117 10.343
05 15 2001 0108	21 52.294	117 10.302
05 15 2001 0110	21 52.254	117 10.259
05 15 2001 0112	21 52.213	117 10.214
05 15 2001 0114	21 52.171	117 10.174
05 15 2001 0116	21 52.133	117 10.134
05 15 2001 0118	21 52.092	117 10.094
05 15 2001 0120	21 52.052	117 10.053
05 15 2001 0122	21 52.013	117 10.011
05 15 2001 0124	21 51.978	117 09.964

TABLE 21. Light bulb drop times and positions, from the *OR3* logbooks.

MM dd yy hhmm (UTC)	latitude N	Longitude E
05 05 2001 0816	21 52.443	117 10.772
05 15 2001 0126	21 51.946	117 09.915
05 15 2001 0128	21 51.916	117 09.868
05 15 2001 0130	21 51.886	117 09.817
05 15 2001 0132	21 51.856	117 09.767
05 15 2001 0134	21 51.824	117 09.718
05 15 2001 0136	21 51.792	117 09.671
05 15 2001 0138	21 51.767	117 09.605
05 15 2001 0140	21 51.857	117 09.606
05 15 2001 0142	21 51.974	117 09.701
05 15 2001 0144	21 52.092	117 09.802
05 15 2001 0146	21 52.204	117 09.904
05 15 2001 0148	21 52.317	117 10.000
05 15 2001 0150	21 52.438	117 10.094
05 15 2001 0152	21 52.549	117 10.192
05 15 2001 0154	21 52.632	117 10.251
05 15 2001 0156	21 52.736	117 10.189
05 15 2001 0158	21 52.810	117 10.123
05 15 2001 0200	21 52.900	117 10.119
05 15 2001 0202	21 53.001	117 10.122
05 15 2001 0204	21 53.094	117 10.137
05 15 2001 0206	21 53.164	117 10.181
05 15 2001 0208	21 53.257	117 10.239
05 15 2001 0210	21 53.343	117 10.297
05 15 2001 0212	21 53.360	117 10.391
05 15 2001 0214	21 53.395	117 10.489
05 15 2001 0216	21 53.430	117 10.595
05 15 2001 0218	21 53.430	117 10.709
05 15 2001 0220	21 53.418	117 10.826
05 15 2001 0222	21 53.351	117 10.936
05 15 2001 0224	21 53.270	117 11.039
05 15 2001 0226	21 53.178	117 11.092
05 15 2001 0228	21 53.083	117 11.120
05 15 2001 0230	21 52.997	117 11.156
05 15 2001 0232	21 52.888	117 11.177
05 15 2001 0234	21 52.778	117 11.142
05 15 2001 0236	21 52.682	117 11.084
05 15 2001 0238	21 52.591	117 11.014

TABLE 21. Light bulb drop times and positions, from the *OR3* logbooks.

MM dd yy hhmm (UTC)	latitude N	Longitude E
05 05 2001 0816	21 52.443	117 10.772
05 15 2001 0240	21 52.509	117 10.929
05 15 2001 0242	21 52.453	117 10.833
05 15 2001 0244	21 52.444	117 10.738
05 15 2001 0246	21 52.445	117 10.641
05 15 2001 0248	21 52.469	117 10.540
05 15 2001 0250	21 52.495	117 10.416
05 15 2001 0252	21 52.521	117 10.288
05 15 2001 0254	21 52.561	117 10.203
05 15 2001 0256	21 52.615	117 10.189
05 15 2001 0258	21 52.723	117 10.156
05 15 2001 0300	21 52.806	117 10.092
05 15 2001 0301	21 52.840	117 10.07
05 15 2001 0302	21 52.879	117 10.062
05 15 2001 0303	21 52.917	117 10.074
05 15 2001 0304	21 52.965	117 10.097
05 15 2001 0305	21 53.016	117 10.115
05 15 2001 0306	21 53.071	117 10.131
05 15 2001 0307	21 53.125	117 10.140
05 15 2001 0308	21 53.174	117 10.154
05 15 2001 0309	21 53.220	117 10.174
05 15 2001 0310	21 53.261	117 10.200
05 15 2001 0311	21 53.298	117 10.231
05 15 2001 0312	21 53.333	117 10.263
05 15 2001 0313	21 53.351	117 10.315
05 15 2001 0314	21 53.371	117 10.372
05 15 2001 0315	21 53.391	117 10.428
05 15 2001 0316	21 53.415	117 10.482
05 15 2001 0317	21 53.423	117 10.538
05 15 2001 0318	21 53.425	117 10.594
05 15 2001 0319	21 53.431	117 10.648
05 15 2001 0320	21 53.435	117 10.705
05 15 2001 0321	21 53.439	117 10.760
05 15 2001 0322	21 53.428	117 10.815
05 15 2001 0323	21 53.398	117 10.863
05 15 2001 0324	21 53.363	117 10.905
05 15 2001 0325	21 53.327	117 10.946
05 15 2001 0326	21 53.296	117 10.986

TABLE 21. Light bulb drop times and positions, from the *OR3* logbooks.

MM dd yy hhmm (UTC)	latitude N	Longitude E
05 05 2001 0816	21 52.443	117 10.772
05 15 2001 0327	21 53.260	117 11.027
05 15 2001 0328	21 53.218	117 11.066
05 15 2001 0329	21 53.177	117 11.105
05 15 2001 0330	21 53.134	117 11.141

3.5 SHARK hydrophone arrays (WHOI/NPS HLA/VLA)

3.5.1 SHARK mooring configuration

The instrument sled for the WHOI ASIAEX 2001 acoustic array is popularly referred to as the "SHARK", short for the "Shark of Science", which is stencilled on it (Figure 15). Attached to the SHARK were 2 acoustic line arrays (see figure 16); one with bouyancy at the end to form a vertical line array (VLA) and one stretched along the bottom to form a horizontal line array (HLA). Sensor spacing on the sixteen vertical array was set at 3.75 meters in order to span a 90m water column reasonably, and thus be able to filter normal modes adequately over the 50-600 Hz band of the acoustic transmissions. However, due to reported fishing activity inshore, the SHARK was deployed further offshore in 124m of water, so that the vertical extent of the array is a smaller fraction of the water column. Some science was thus sacrificed for equipment security in the heavily fished SCS waters. The 48 horizontal array elements were spaced fifteen meters apart, so that the total length would be adequate for acoustic coherence studies. This spacing is not half-wavelength for any but the lowest frequency transmitted, 50 Hz. This was a conscious trade-off, in which we sacrificed Nyquist sampling in the horizontal for total array length

3.5.2 Array element localization

Benthos navigation transponders were positioned in a triangle non-equidistant from the SHARK to estimate mooring motion of the VLA and to estimate hydrophone placement and distances for the HLA. The sled (SHARK), the outboard end of the HLA (tail) and its two bottom-mounted transponders used for mooring motion navigation were all acoustically surveyed at deployment and recovery to find their exact positions. Both surveys produced consistent results. Since the *FR1* used an offset for chart calibration (see Table 4), *please use the surveyed positions for accurate mooring locations.*

The transponders were positioned at slightly different distances from the mooring so that the acoustic responses would not arrive at the same time and interfere with each other. Selected hydrophones on the VLA and the HLA were used for recording navigation. These are labeled as "nav" in Tables 26 and 27.

All hydrophones on the VLA and the HLA performed consistently well throughout the experiment. The data retrieved does contain small gaps, however, due to a minor malfunction of a 'watchdog' feature employed in the electronics to recover from problems. The watchdog feature often mistook multipath arrivals from the navigation transponders for reading failures and performed a hard system reboot. This reboot left gaps in the data of up to a minute duration. However, these were not critical to the overall performance of the SHARK nor overly harmful to the integrity of the data.

3.5.3 SHARK environmental support.

One Starmon and five Seamon temperature loggers (T-pods), and four SeaBird Electronics temperature/pressure sensors were attached to the vertical array to measure the water column temporal variability at the receiver site and mooring motion of the VLA. The depths for the temperature sensors in Table 28 were calculated using the array pressure sensor measurements at slack high tide for water column depth along with the hand-measured distances between sensors.

3.5.4 Time drift of SHARK recording system.

SHARK data acquisition was started on 05/01/01 at 0440 hours (UTC) at which time the SHARK internal clock lagged GPS time by 4.4 microseconds. Upon recovery, the SHARK internal clock led GPS time by 2200 microseconds. Using these 2 measurements, and assuming linear drift over a 16 day deployment, the SHARK internal clock was fast relative to GPS time by an average of 5.73 microseconds per hour, which is about 1.8 parts per billion.

3.5.5 SHARK information.

Tables of information about the WHOI/NPS VLA/HLA include the following. In Table 22, the deployment/recovery times and positions of the array and its major subcomponents are presented, using the *FR1* bridge GPS positions. These positions were not corrected for the *FR1* bridge offset since more accurate positions will be given from the acoustic survey. In Table 23, the deployment survey of the VLA/HLA subcomponents using the WHOI system is presented, complemented by the same survey done upon recovery in Table 24. One quickly notes the difference between the two tables, perhaps indicating some motion of the equipment during the deployment. The differences between the deployment and recovery positions are presented in Table 25. It is seen that these distances are rather small, however within our survey error. This indicates that the motion of these heavier array components was relatively minor. However, the lighter HLA array cable along the bottom saw somewhat more movement, as will be discussed later in this report in Section 5.0. In Table 26, the spacings of the vertical array hydrophone elements are shown. In Table 27, the spacings of the horizontal array elements based on a fully stretched out configuration, which is not the actual experimental case, are shown

To give the reader some feeling for the data collected by the WHOI/NPS VLA/HLA and its associated environmental sensors, so as to guide their choices for further analysis work, representative samples of the data are included in the following figures. Figure 9 shows a temperature time series vs. depth measured by the temperature sensors located on the VLA portion of the acoustic receiver. The extreme time variability, vertical variability, and range of temperatures (14 to 28 degrees C) shows that the vertical temperature field must be adequately measured if one hopes to understand the acoustic data. Blowups in time of portions of Figure 9 are shown in Figures 10 and 11, which emphasize the strong internal tides and associated high frequency variability of the temperature field at the receiver site. Another environmental record of great interest is the pressure field that is measured at the top of the vertical array, which indicates how the depth of the array is affected by tides, currents, and storm surges. This record is shown in Figure 12. The semidiurnal tidal signal is clearly seen throughout the data record, along with some low frequency variation (that may be due to the storm surge and currents of a passing typhoon) and some high frequency variation between days 5/10/01 and 5/15/01 that may be due to surface waves and the spring tide soliton field. This record, along with current meter records, will be very useful in understanding both acoustic and oceanographic variability. A sample of the acoustic data, one of the prime objectives in ASIAEX, is shown in Figure 13. This spectrogram time series, taken over 0-800 Hz in frequency and 0.3 hours in time, shows the signatures of all the sources used in ASIAEX, both moored and towed. In the 50-200 Hz band, swept signals produced by the J-15-3 towed source are evident. The strong signal at 224 Hz is from the deep moored WRC source. The 230-250 Hz swept signal is also from the J-15-3 towed source. The 270-330 Hz LFM signal is from the shallow moored NRL source. The 400 Hz signals are from the deep and shallow NPS moored sources, on an alternating cycle. The 470-530 Hz signals are from the second shallow moored NRL source. Finally, the swept signals from 550-600 Hz are again from the J-15-3 towed unit.

One of the prime experimental objectives for ASIAEX was to fill the 50-600 Hz band, which was accomplished as seen here. The spectrogram in Figure 13 has very minimal processing gain, and that even without such signal boosting, the signal to noise ratio is quite high. At various times, however, the receptions were swamped by ship noise, as shown in Figure 14. Though the experiment area was somewhat removed from the main shipping lanes, occasional traffic (including our own research ships!) passed close enough to the array to swamp the unprocessed signals. It should be noted that with the large amount of array, pulse compression, and time averaging gain available, the data can probably be processed through what appear to be hopelessly corrupted signals, such as the Figure 14 example.

To finish the description of the WHOI/NPS VLA/HLA system, a brief physical look at the equipment is presented. The SHARK sled, which contained the electronics, batteries, and attachment points for the arrays, is shown in Figure 15. This is a comparatively compact piece of equipment, considering the capabilities of the array. The mooring diagram for the VLA/HLA system is shown in Figure 16. The reader is again reminded that the array was eventually deployed in 124m water depth, not the 90m originally intended and shown in Figure 16.

For more information on the SHARK and the acoustic data format, refer to section 4.0.

TABLE 22. SHARK instrument sled. The positions here include the *FR1* bridge offset and are only used for initialization of the acoustic surveys described below.

mooring/view number	16
deployed	05/02/01 1403 (local)
recovered	05/18/01 1300 (local)
Sled deployment position (*FR1*)	21 52.944 N 117 10.622 E
Tail deployment position (*FR1*)	21 52.655 N 117 10.324 E
North Ball deployment position (*FR1*)	21 52.900 117 10.561
South Ball deployment position (*FR1*)	21 52.429 117 10.761
deployment depth (log)	120.2 m
deployment depth (from pressure sensor)	124.5 m

TABLE 23. Final results from deployment survey using WHOI GPS.

mooring	surveyed latitude N	surveyed longitude E
sled (SHARK)	21 52.8188	117 11.0808
tail	21 52.6294	117 10.8837
north ball	21 52.9895	117 11.0541
south ball	21 52.3547	117 11.2171

TABLE 24. Final results from recovery survey using WHOI GPS.

mooring	surveyed latitude N	surveyed longitude E
sled (SHARK)	21 52.8168	117 11.0755
tail	21 52.6310	117 10.8807
north ball	21 52.9837	117 11.0447
south ball	21 52.3496	117 11.2186

TABLE 25. Distance differences between deployment and recovery surveys.

mooring	difference (meters)
sled (SHARK)	9.59
tail	5.92
north ball	19.41
south ball	9.76

TABLE 26. VLA hydrophone predeployment configuration. phones 0-9 were spaced at 3.75 meters and phones 10-sled were spaced at 7.5 meters.

System Channel number	Distance from top element in water column (m)
0 (nav)	0
1	3.75
2	7.5
3	11.25
4	15
5	18.75
6 (nav)	22.5
7	26.25
8	30
9	33.75
10 (nav)	41.25
11	48.75
12	56.25
13 (nav)	63.75
14	71.25
15	78.75
Sled (bottom)	81.75

TABLE 27. HLA hydrophone predeployment configuration (stretched full length). All sensors had 15 meter spacing throughout.

System Channel number	Distance from SHARK (m)
16 (nav)	467
17	452
18	437
19	422
20	407
21	392
22	377
23	362
24	347
25	332
26 (nav)	317
27	302
28	287
29	272
30	257
31	242
32	227
33	212
34	197
35	182
36 (nav)	167
37	152
38	137
39	122
40	107
41	92
42	77
43	62
44	47
45	32
46	17
47	2
SHARK sled	

TABLE 28. SHARK VLA environment sensors.

Sensor	Depth (m) at deployment	Sampling period (minutes)
Seamon T-pod C319	39.5	2
SBE T/P 294 (at array element #1)	46.5	1
Seamon T-pod C336	57.3	2
SBE T/P 291	67.2	1
Seamon T-pod C313	77.3	2
SBE T/P 292	87.4	1
Seamon T-pod C314	97.3	2
SBE T/P 323	107.6	1
Seamon T-pod C315	117.4	2
Starmon T-0210 (on sled)	123.5	1

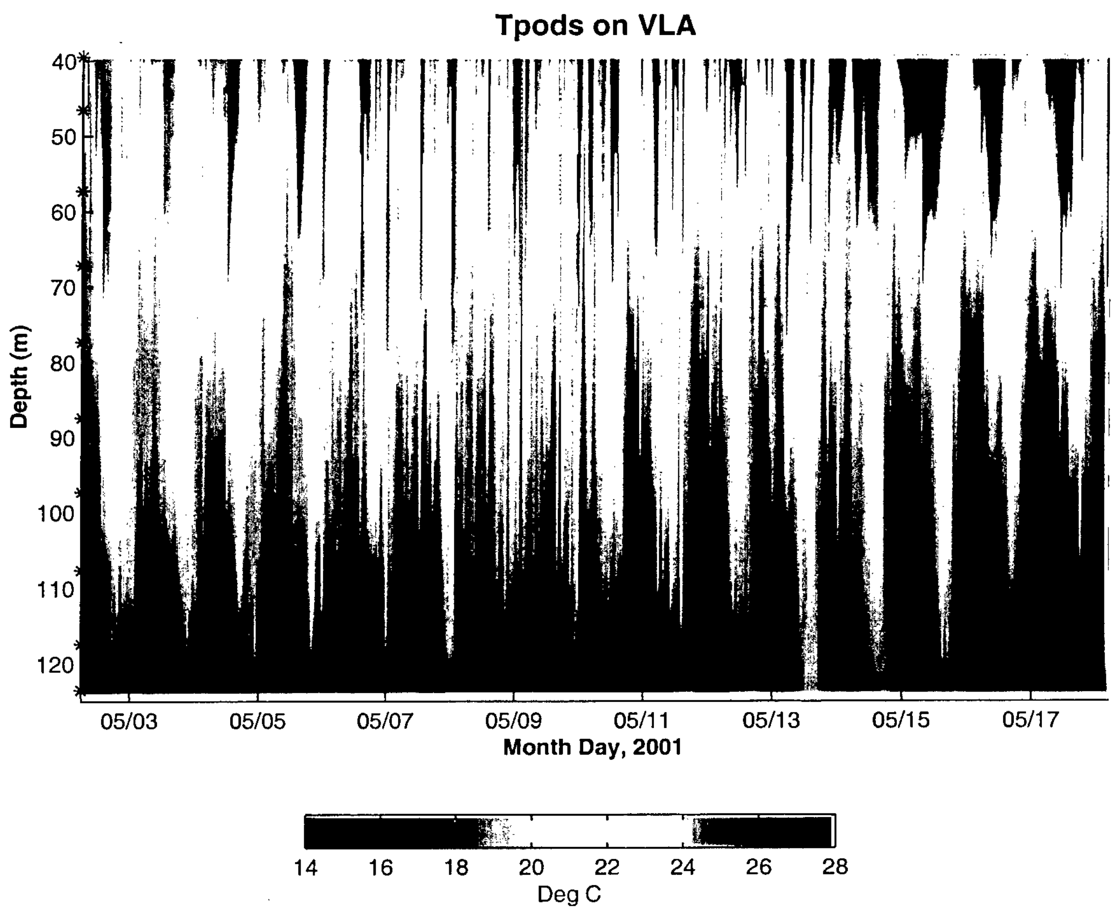

FIGURE 9. Temperatures at SHARK VLA for entire deployment. Sensor depths are shown as *'s.

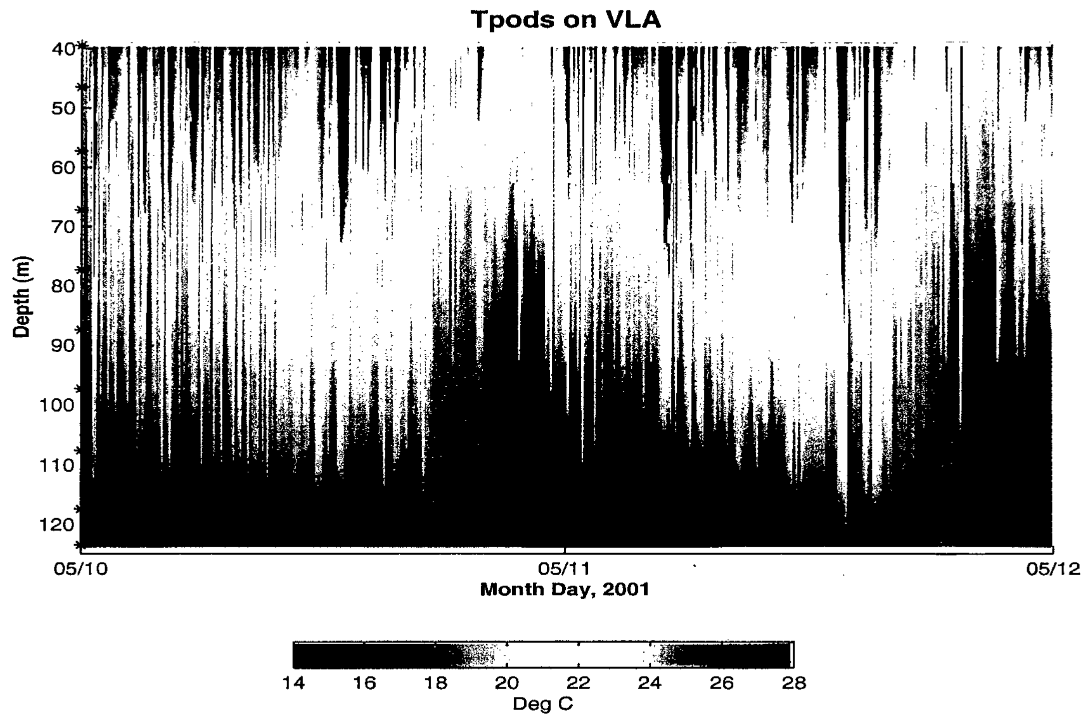

FIGURE 10. Temperatures at SHARK VLA for days May 10 to May 12. Sensor depths are shown as *'s at left.

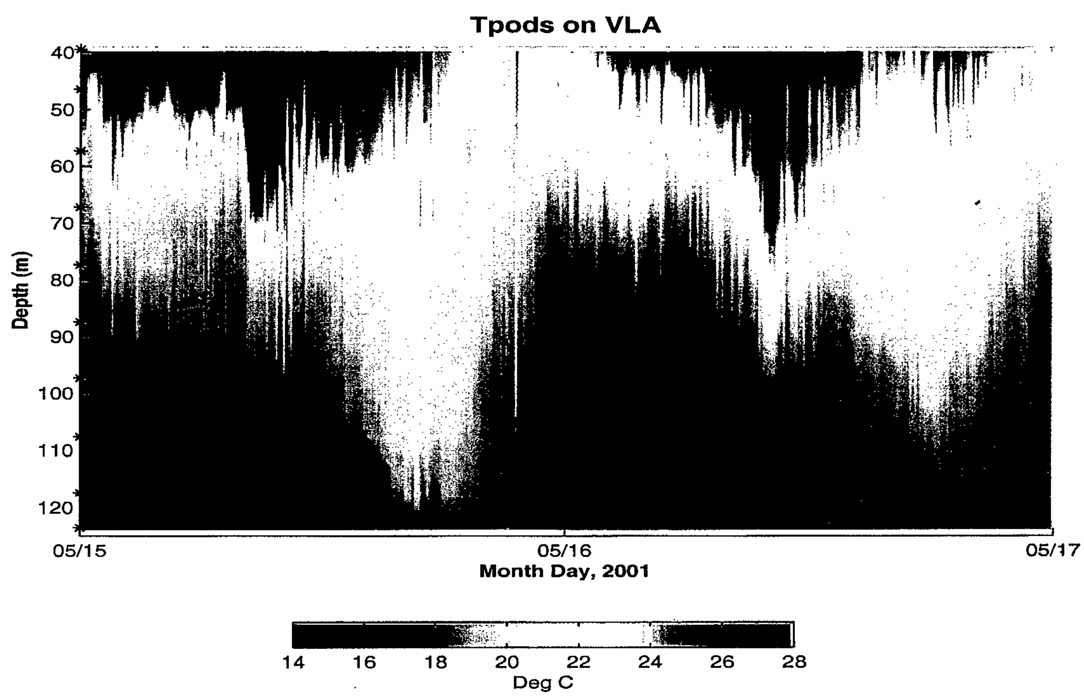

FIGURE 11. Temperatures at SHARK VLA for days May 15 to May 17. Sensor depths are shown as *'s at left.

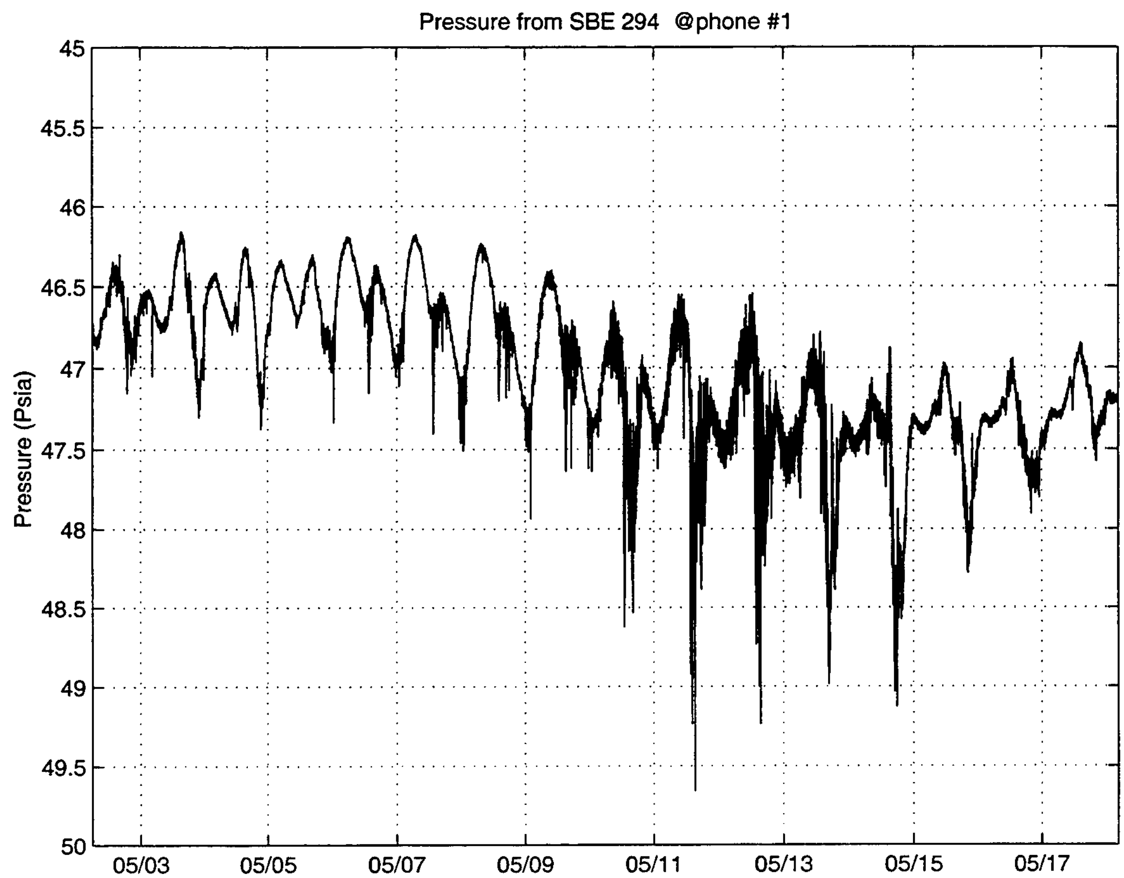

FIGURE 12. SHARK pressure values at hydrophone #1, approximately 80 meters above the bottom.

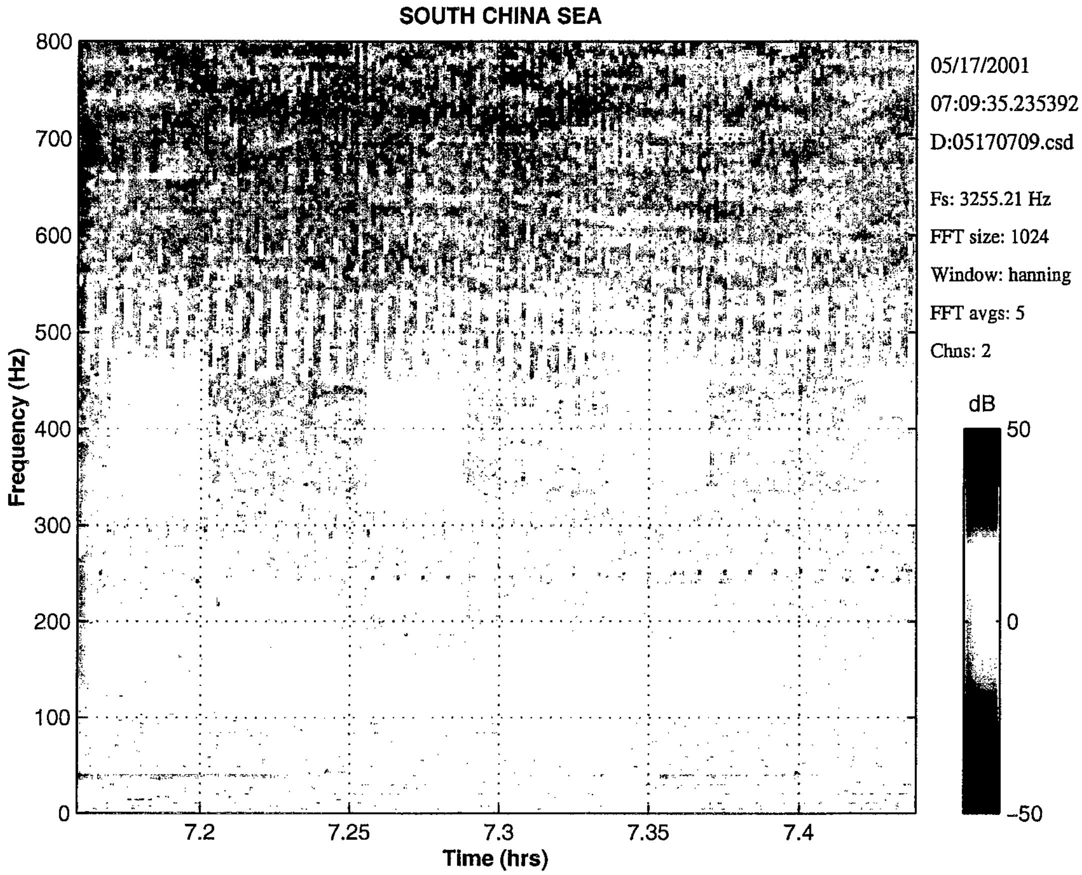

FIGURE 13. Spectrogram for SHARK receptions for May 17, 2001, hydrophone 2 on the VLA, showing all sources. Signals from both 400 Hz phase-encoded sources and the 224 Hz phase-encoded source are visible, as are those of the 300 and 500 Hz LFM sweep sources. The smaller bandwidth peaks that range from 50 Hz to 600 Hz are from the towed J-15-3.

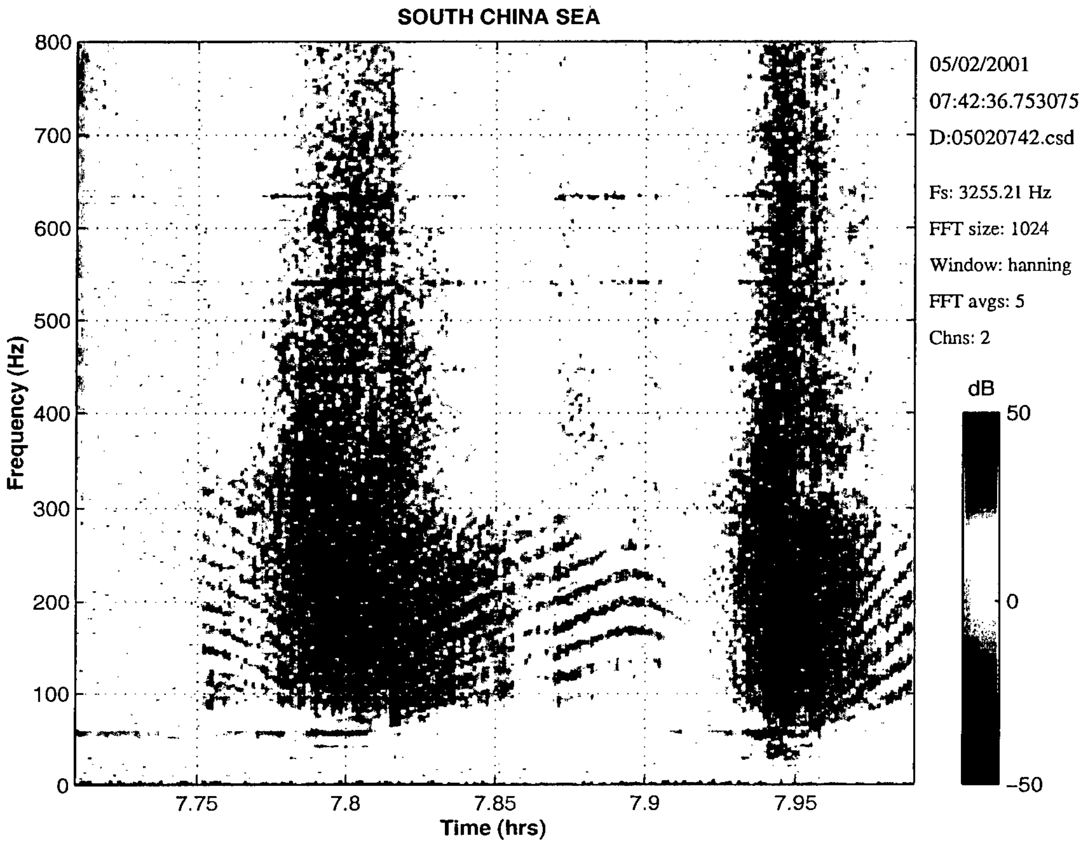

FIGURE 14. Spectrogram for SHARK receptions for May 2, 2002. Signal is swamped by ship noise.

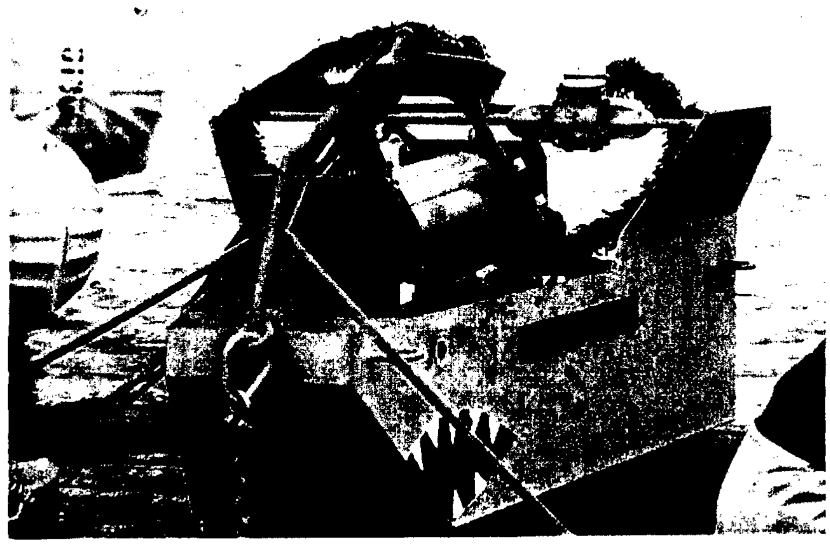

FIGURE 15. SHARK ready for deployment on deck of *FR1* during ASIAEX01.

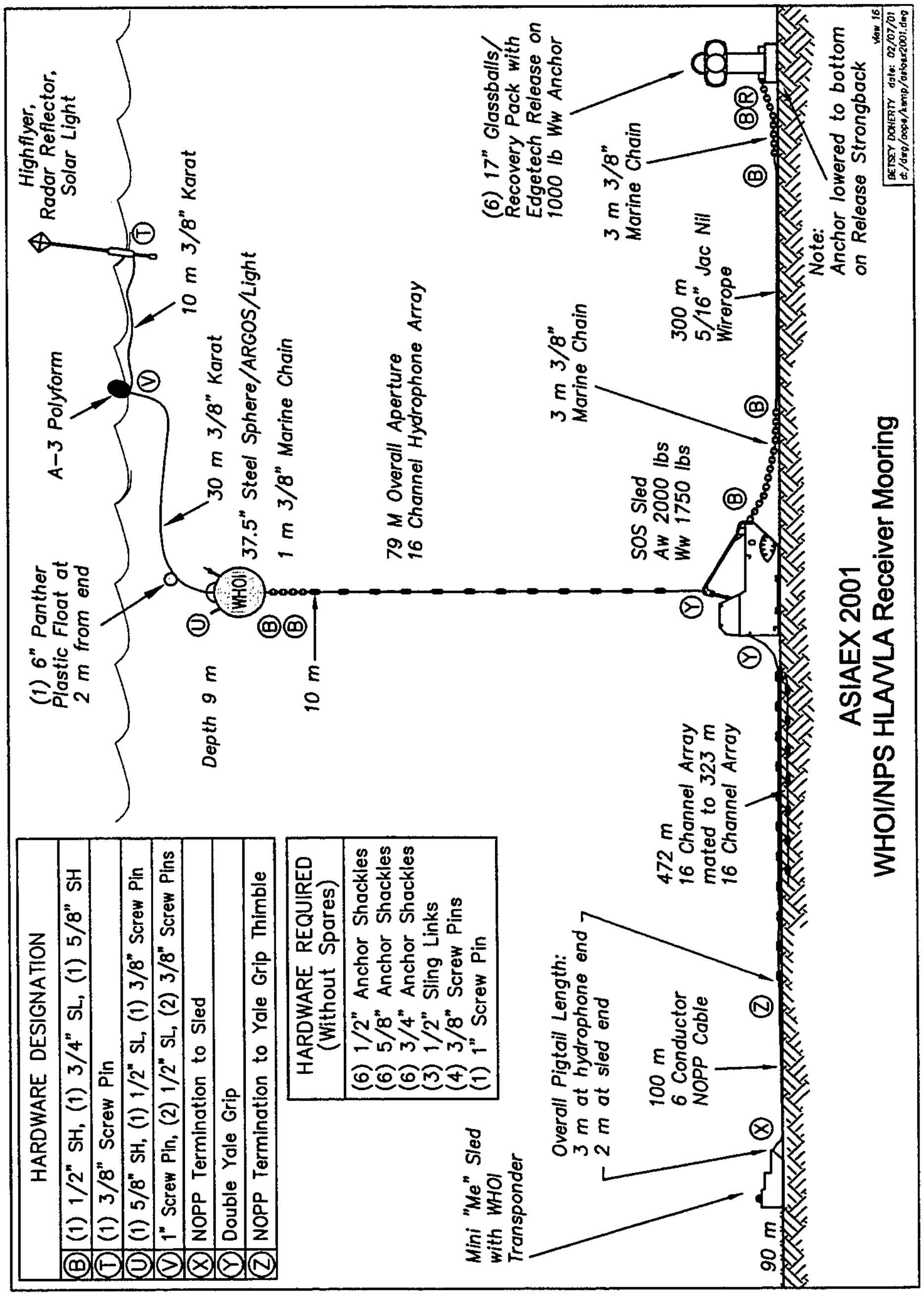

FIGURE 16. SHARK mooring configuration.

3.6 Thermistor strings

Two thermistor strings having eleven sensors each were deployed from the *FR1*. One string was located near the 3 shallow acoustic sources on the along-shelf propagation path and one was located at a slightly deeper site (139 meter water depth) in the eastern section of the experiment area (see Figure 1). The T-strings sampled often enough to resolve internal waves, and the measured thermocline fluctuations can in turn be used for accurate acoustical mode decomposition. Each string took eleven temperature samples (one per thermistor) every minute. Individual temperature sensors were also attached to the mooring, both at the surface on the hi-flyer (surface radar reflector) and at the bottom on the release to complete the sampling of the entire water column. The shallow thermistor string #307 lost its hi-flyer, presumably to fishing activity. Significant subtidal period and internal wave period variability is evident in both thermistor strings.

3.6.1 Thermistor string format

Both thermistor strings data sets have the same format. The data were stored in 19 columns per sample indicating date, time, and temperature. Columns 3,4,16,17,18, and 19 in the data were used only during development and testing and contain no useful information. The software was initially designed for an experiment in 1995 and was not changed for this one, thus the data reference date is for the year 1995. Each temperature datum consists of a sum of 30 samples in engineering units, thus needing an interpolation scheme obtained from post-experiment calibrations to convert to temperature in degrees C.

TABLE 29. Thermistor string data format.

Column	description
1	Julian day 1995 (noon Jan 1, 1995 = 1.5)
2	minutes into day
3	not used
4	not used
5-15 (11 sensors)	temperature in engineering units
16	not used
17	not used
18	not used
19	not used

3.6.2 Deep thermistor string

The deployment/recovery times, deployment positions, and water depth of the deep thermistor string are presented in Table 30. In Table 31, the depths of the individual thermistor sensors are shown. In Table 32, the depths of the independent temperature sensors attached to the thermistor mooring are given. In Figure 17, the time-depth series of temperature measured by the deep thermistor string, plus the independent sensors, is shown. A very strong internal tide signature is once again seen here. Figure 18 presents a blowup of two days of data, showing the high frequency solitons in more detail. Of great interest in this figure is the intensity/size of the solitons, with the strongest waves penetrating down 120m, almost to the bottom. These are undoubtedly some of the strongest non-linear waves observed anywhere in the world. The mooring diagram for the deep thermistor string is shown in Figure 19. Please note that the intended depth of deployment shown in Figure 19, 125m, is not the actual depth of deployment (139.0m). Table 33 lists the post-experiment calibrations performed in a controlled bath at WHOI on September 9, 2001. These samples should be used for converting the T-string data from engineering units to temperature. Values that are 0 or 30690 should be discarded since they are outside the operating limit of the thermistor string.

TABLE 30. Deep thermistor string #598.

mooring/view number	8
system number	598
deployed	05/03/01 0926 (local)
recovered	05/20/01 0825 (local)
latitude N (*FR1*)	21 55.285
corrected latitude N	21 55.193
longitude E (*FR1*)	117 34.609
corrected longitude E	117 35.088
depth (ship log)	139.0
Sampling interval (min)	1

TABLE 31. Deep thermistor string #598 sensor configuration. All depths are calculated using the deployment logged depth from *FR1* echosounder.

Sensor number	Depth (m)
1	132.74
2	123.04
3	113.08
4	103.16
5	93.28
6	83.38
7	73.48
8	63.58
9	53.72
10	43.9
11	34.0

TABLE 32. Temperature sensors attached to the deep thermistor string #598. All depths are calculated using the deployment logged depth from *FR1* echosounder.

Sensor number	Depth (m)
t0209 (on float)	21.7
c291 (on release)	135.15

TABLE 33. Thermistor string #598 post cruise calibration. A sample in engineering units for each thermistor is shown at each controlled temperature.

temp C	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
9.085	30690	30690	30690	30690	30690	30690	30690	30690	30690	30690	30690
12.084	28183	28155	28100	28134	28096	28131	28102	28042	28089	28086	28114
15.194	24529	24500	24519	24457	24427	24480	24437	24374	24449	24436	24444
18.132	20624	20634	20520	20559	20550	20605	20586	20462	20583	20512	20578
20.981	16663	16608	16472	16517	16509	16584	16564	16434	16567	16548	16546
23.923	12032	11973	11794	11844	11844	11939	11917	11759	11932	11904	11886
27.066	6711	6643	6716	6467	6490	6591	6587	6393	6616	6578	6542
39.070	915	820	544	604	626	770	767	528	807	756	705

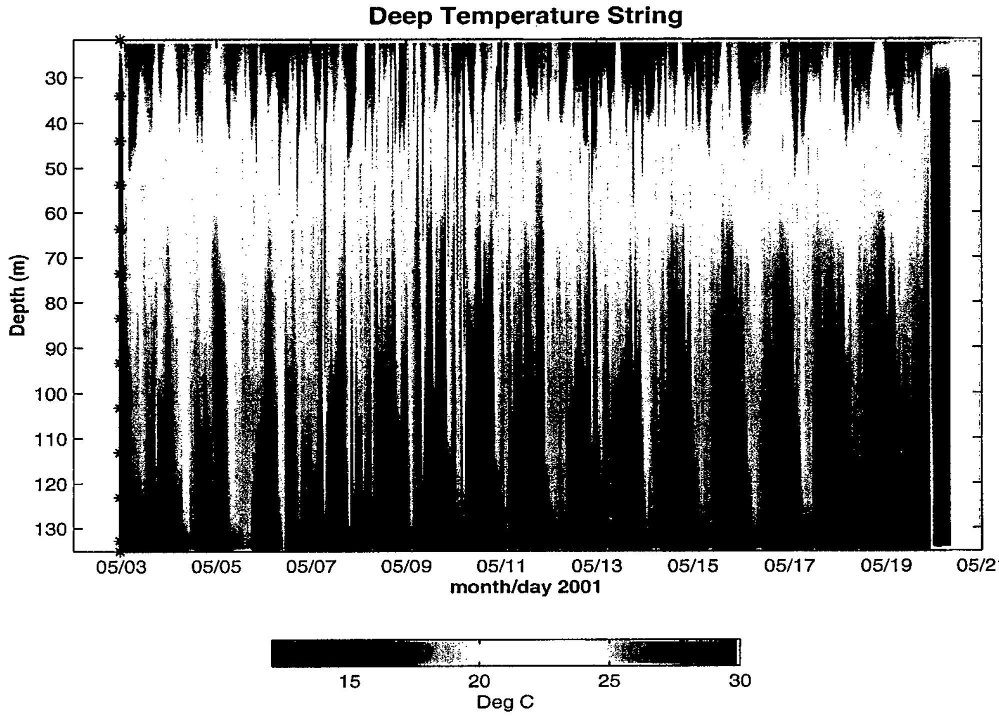

FIGURE 17. Time series of entire deployment of the deep thermistor string. Sensor depths are denoted by a * shown at left.

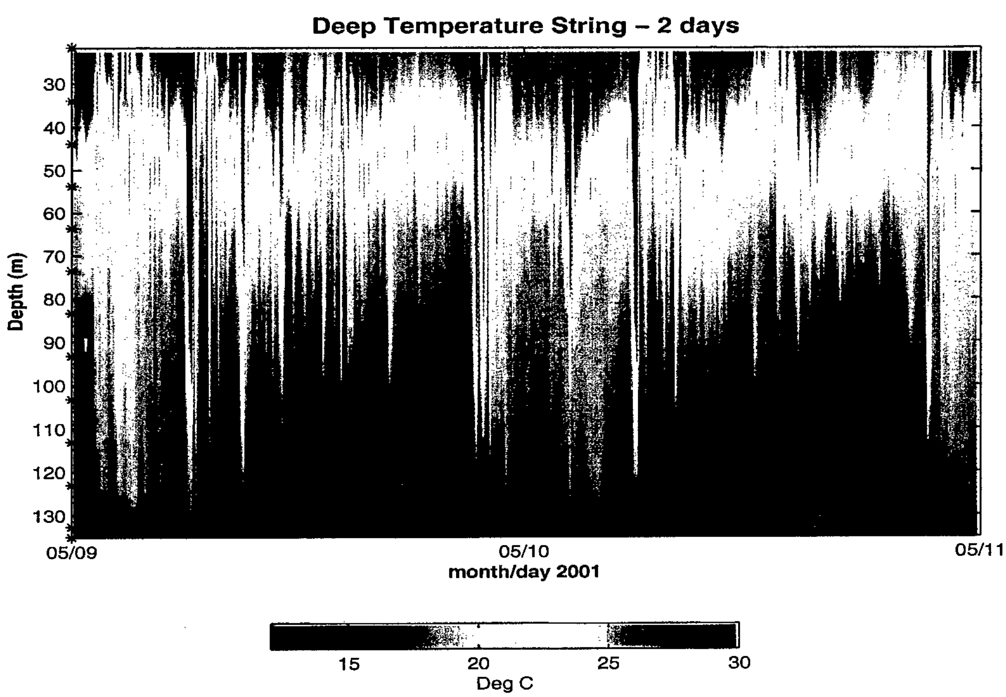

FIGURE 18. 2 day closeup of the deep thermistor string, Sensor depths are denoted by a *.

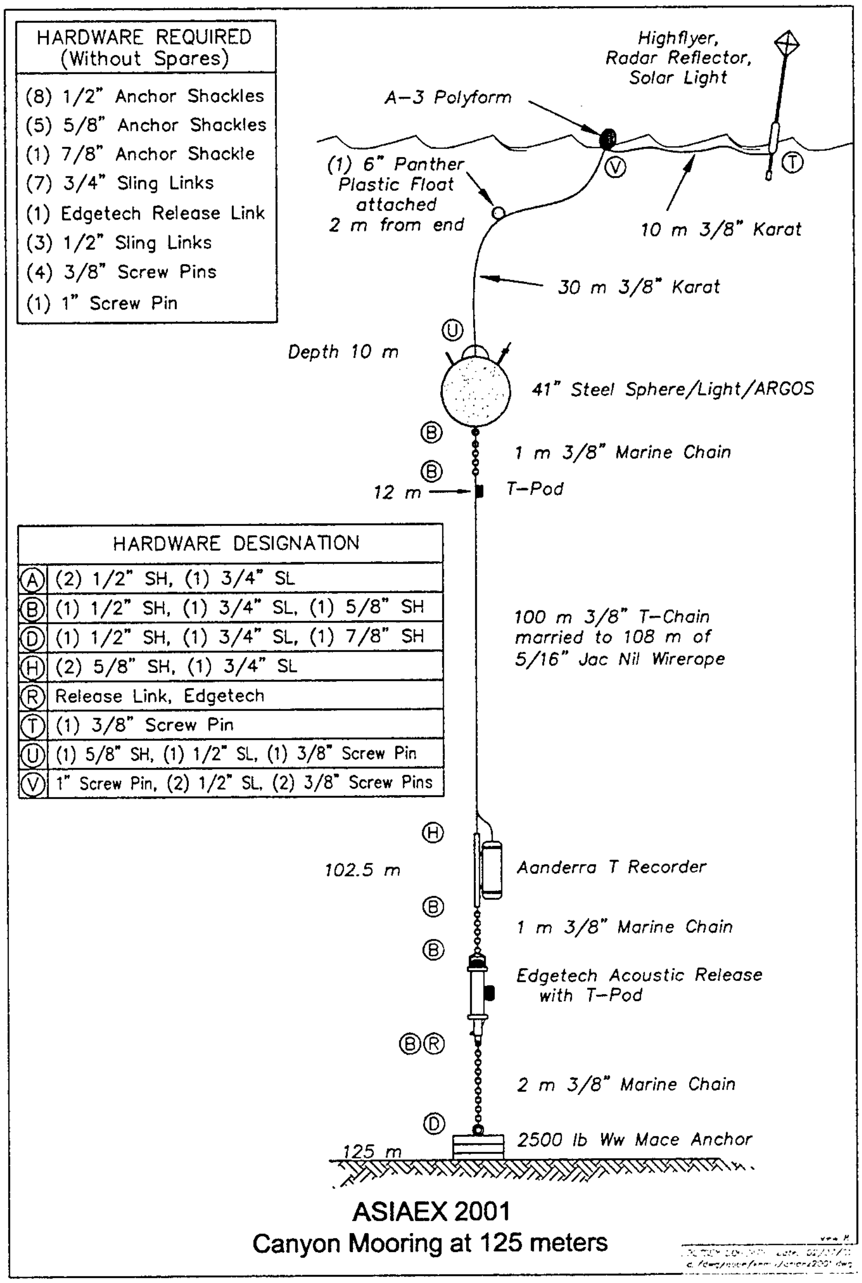

FIGURE 19. Mooring configuration for the deep thermistor string (mooring 8).

3.6.3 Shallow thermistor string near sources

The shallow thermistor string was located near the three sources at the eastern end of the along-shelf propagation path. This T-string's sensor structure was too long for the originally intended shallow depth, so it was folded down at the top of the mooring above sensor #7.

The deployment/recovery times, deployment positions, and water depth of the shallow thermistor string are presented in Table 34. In Table 35, the depths of the individual thermistor sensors are shown. In Table 36, the depth of the independent temperature sensor attached to the thermistor mooring is displayed. In Figure 20, the time-depth series of temperature measured by the shallow thermistor string, plus the independent sensor, is shown. A very strong internal tide signature is once again seen here. Figure 21 presents a blowup of two days of data, showing the high frequency solitons in more detail. As is seen in the deep thermistor string data, the soliton field is quite intense. The mooring diagram for the shallow thermistor string is shown in Figure 22. Please note that the intended depth of deployment shown in Figure 22, 80m, is not the actual depth of deployment (111.7m).

Table 37 lists the post-experiment calibrations performed in a temperature controlled bath at WHOI on September 9, 2001. These samples should be used for converting the T-string data from engineering units to temperature. Values that are 0 or 30690 should be discarded since they are outside the operating limit of the thermistor string.

The data from this instrument isn't as consistent as thermistor string #598. Thermistors 1, 5, 7, and 8 performed well and need only those temperature calibrations for conversion. Thermistors 3 and 11 both are bad and should not be used. Thermistors 2 and 4 have a bias problem after converting to temperature. Thermistor 2 is 1.5 degrees C too high and thermistor 4 is 1.5 degrees C too low. Temperature calibration results for thermistor 1 should be used to convert thermistor 6 to temperature. Thermistor 6 took good data during ASIAEX but the quality of the data has eroded since returning to WHOI. Thermistor 9 had both an offset and a drift problem. Since this thermistor is near thermistor 6, which took good data, it can be ignored.

TABLE 34. Shallow thermistor string #307.

mooring/view number	7
system number	307
logging started	day 2301 = 4/19/01
deployed	04/30/01 0854 (local) 0054 (Z)
recovered	05/20/01 1035 (local) 0235 (Z)
latitude N (*FR1*)	21 56.449
corrected latitude N	21 56.357
longitude E (*FR1*)	117 20.811
corrected longitude E	117 21.290
depth (ship log)	111.7
sampling interval (min)	1

TABLE 35. Deep thermistor string #307 sensor configuration. Depths are calculated using FR1 echosounder logged deployment depth.

Sensor number	Depth (m)
1	105.85
2	96.12
3	86.22
11	78.07
4	76.31
10	68.18
5	66.44
09	58.33
6	56.59
08	48.44
7	46.71

TABLE 36. Temperature sensors attached to the deep thermistor string #307. Depths are calculated using the *FR1* echosounder logged deployment depth.

Sensor	Depth (m)
c324 (on release)	108.26

TABLE 37. Thermistor string #307 post cruise calibration. A sample in engineering units for each thermistor is shown at each controlled temperature.

temp C	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
9.085	30690	29816	N/A	28090	30690	27821	30690	30690	28566	29962	22463
12.084	27723	26528	N/A	24027	27576	24606	27647	27713	25220	26711	18528
15.194	23990	22691	N/A	18882	23845	20877	23898	23964	21255	22887	14083
18.132	20097	18685	N/A	13578	19931	17129	19985	20088	17103	18965	9374
20.981	16000	14564	N/A	8249	15800	13064	15871	15977	12641	14817	4707
23.923	11325	9822	N/A	3336	11093	8570	11223	11327	7732	10102	0
27.066	5914	4368	N/A	0	5655	3326	5772	5906	2221	4656	0
39.070	62	0	N/A	0	0	0	0	52	0	0	0

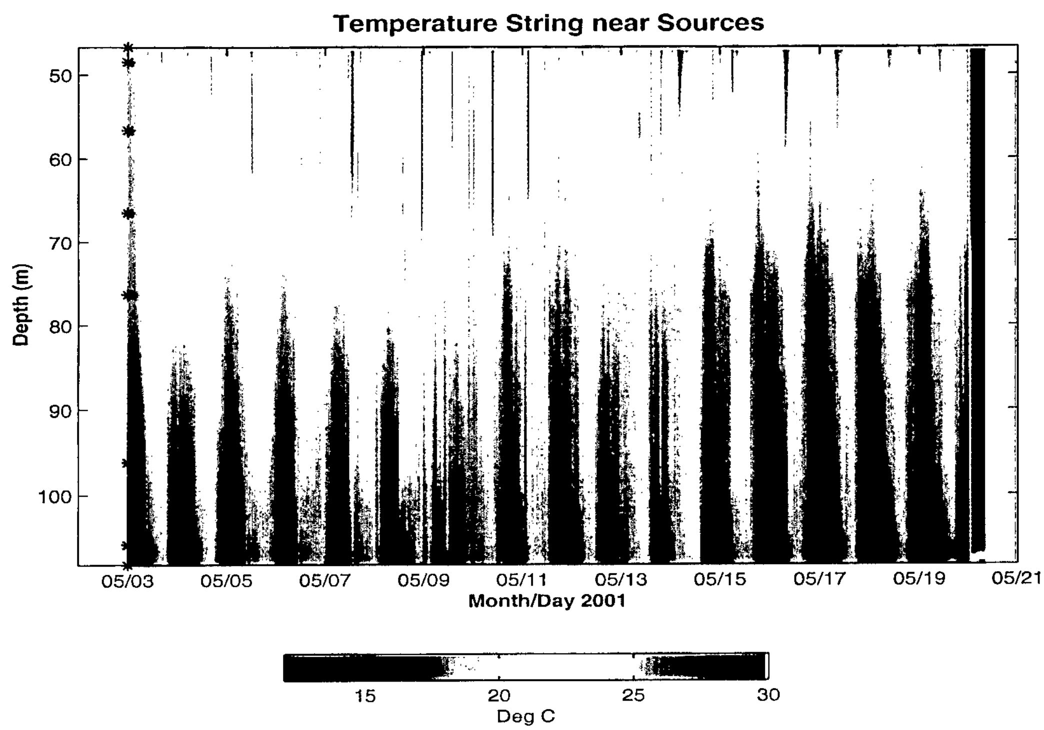

FIGURE 20. Shallow thermistor string #307 temperature data. Thermistor depths are denoted by a * shown at left.

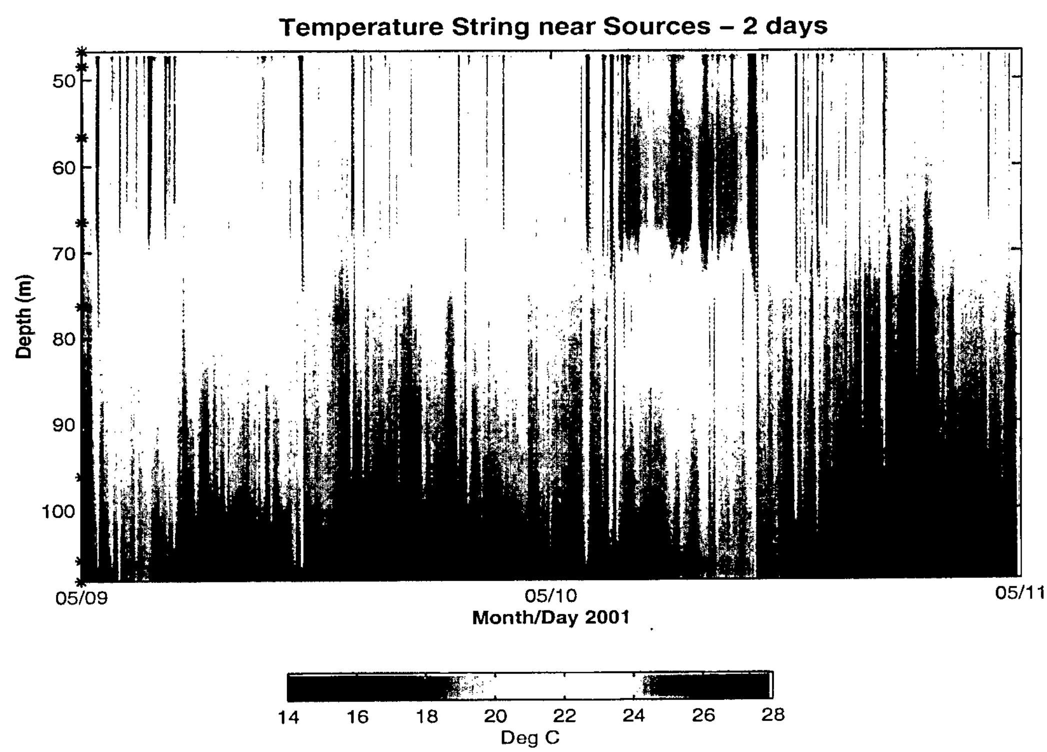

FIGURE 21. 2 day shallow thermistor string #307 temperature data with sensor depths as a *.

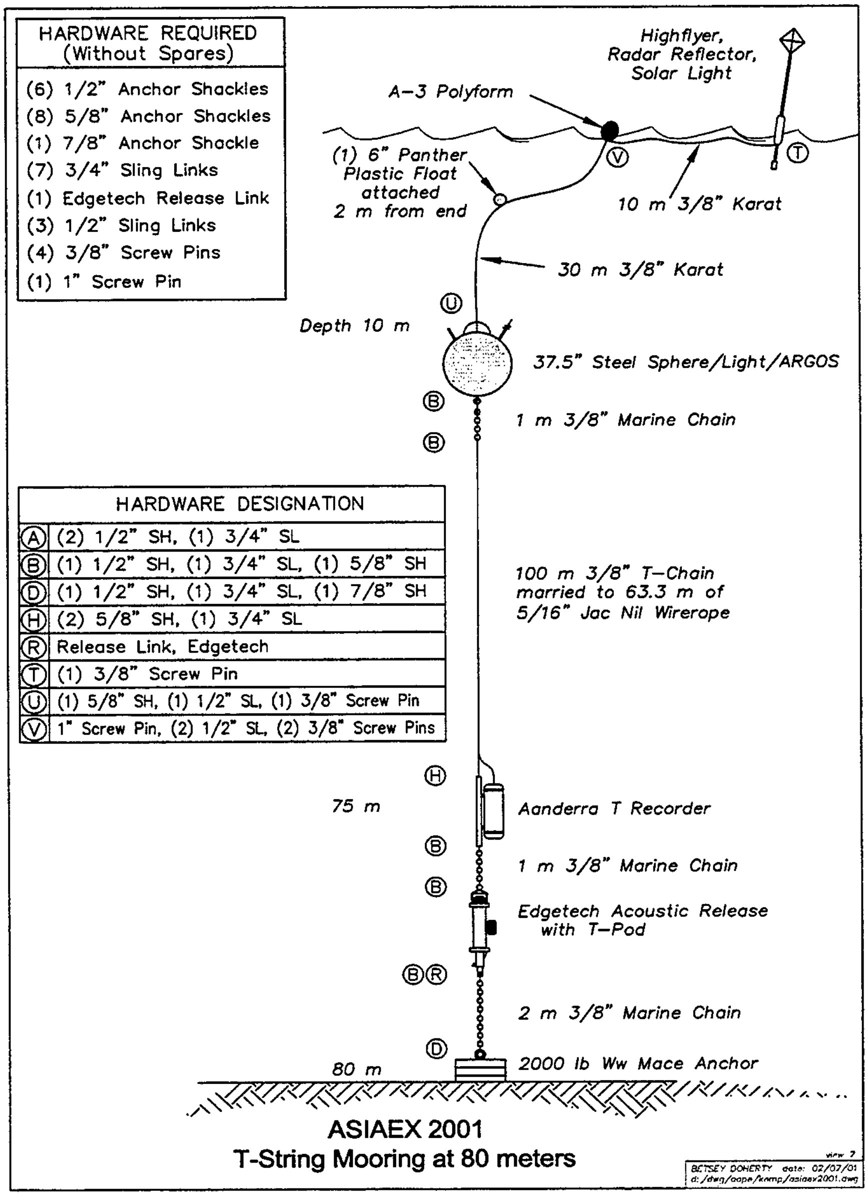

FIGURE 22. Shallow thermistor string mooring configuration (mooring 7).

3.7 Shipboard CTD

Eleven CTD casts were performed by the crew during the mooring deployment leg on the *FR1*. CTD casts were performed at most mooring locations, sampling temperature and salinity vs. depth. The scientific party was told that the crew performing the CTD casts would get extra pay if the casts went into deep water (over 300 meters) and was more than happy to oblige in this matter!

Table 38 reports the positions and water depths of the CTD casts. The cast numbers correspond to the mooring designator, and so these numbers go up to 18, despite there being only 11 casts. A plan view of the CTD cast positions is shown in Figure 23. The temperature profiles from the up-casts and down-casts at the eleven stations are shown in Figures 24, 25, and 26. One notes both the pronounced downward acoustic refraction character and the strong similarity of the profiles.

TABLE 38. ***FR1*** **CTD locations.**

Cast number	lat N long E	water depth (m)
1	21 56.4775 117 20.8697	93
2	21 35.88 117 16.50	312
8	21 52.3447 117 10.6723	109
11	22 06.8942 116 48.9259	59
12	22 03.8821 116 39.9255	65
13	21 56.9021 116 42.5110	71
14	21 48.9743 116 45.7033	99
15	21 42.4261 116 48.675	220
16	21 32.9987 116 52.3839	308
17	21 36.5317 117 02.5844	279
18	21 55.3547 117 35.3014	121

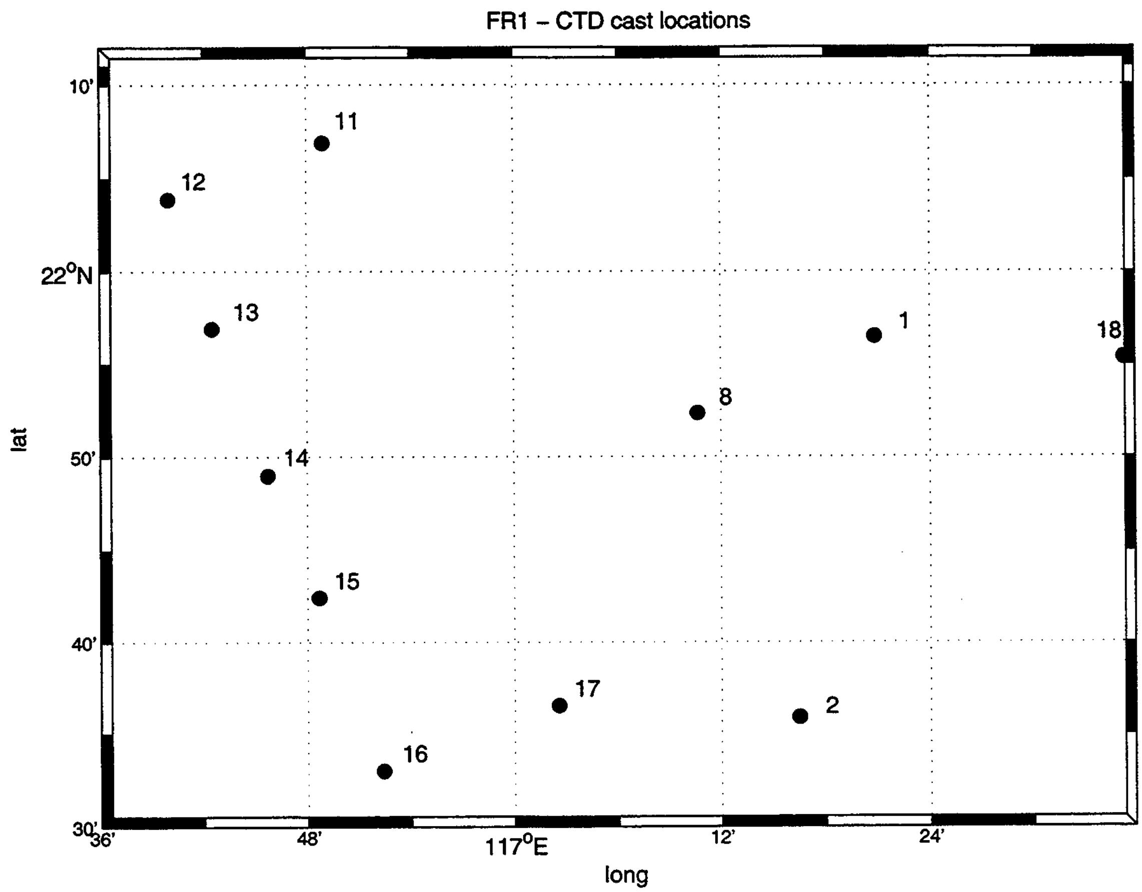

FIGURE 23. ***FR1*** **CTD locations.**

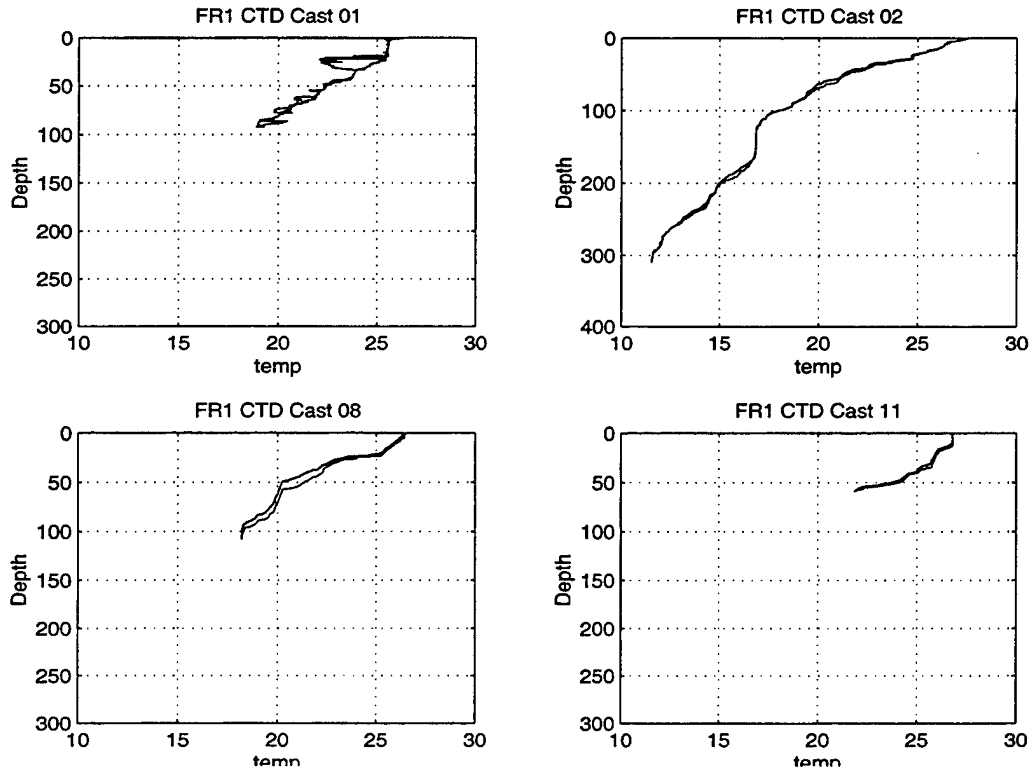

FIGURE 24. ***FR1* CTD temperatures from casts 1,2,8,11.**

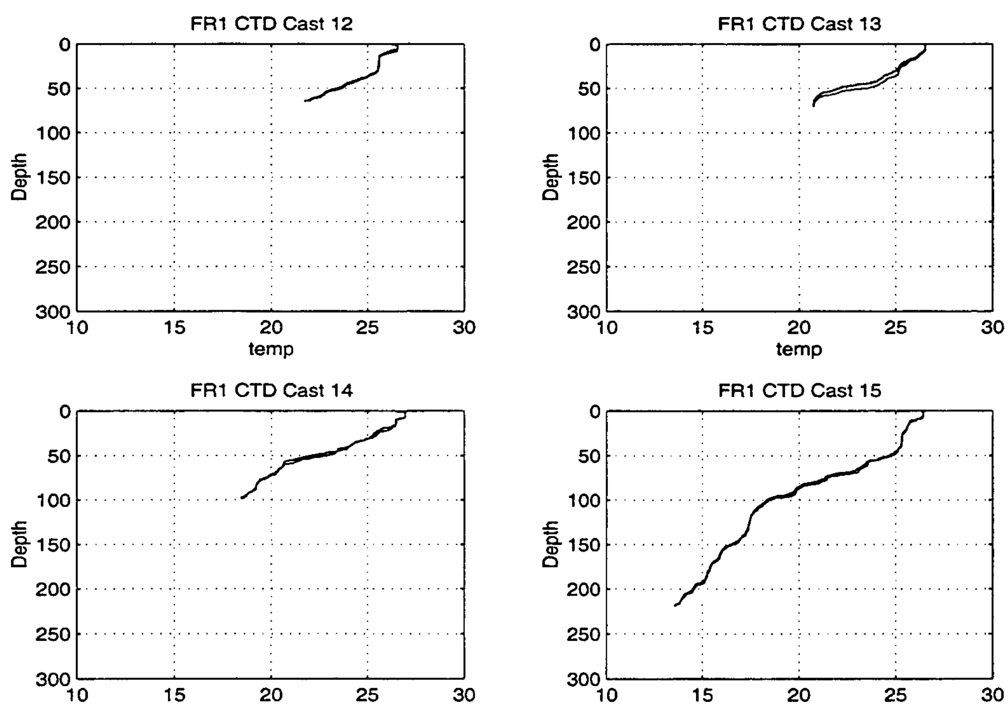

FIGURE 25. ***FR1* CTD temperatures from casts 12, 13, 14, 15.**

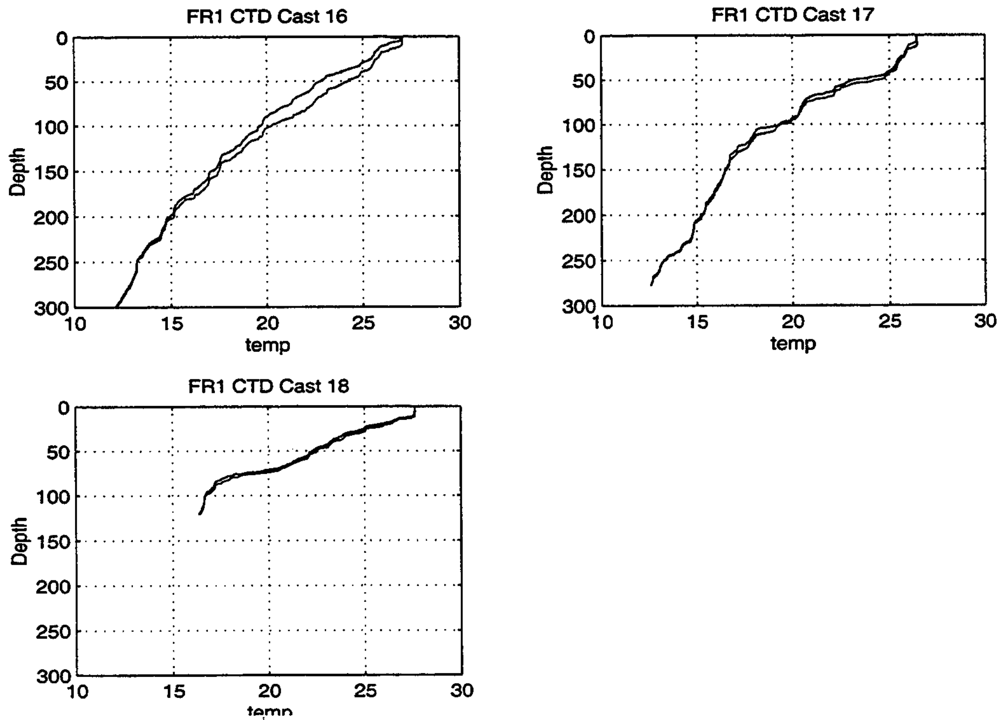

FIGURE 26. *FR1* CTD temperatures from casts 16, 17, 18.

4.0 SHARK HLA/VLA acoustic data

4.1 SHARK HLA/VLA data acquisition system and data format

The ASIAEX01 SHARK is a weighted instrument sled holding two 10 inch diameter, four foot long pressure cases. One case houses the recording electronics, including a 1 terabyte disk array, computer, analog-to-digital converters, stable timebase and power converters, while the other case houses a 14KWH alkaline battery stack. The recording electronics consists of a seven slot ISA backplane with one slot populated by a 3-position PC104 mezzanine board. The remaining slots are loaded with six 8 channel, 24 bit ADC boards with differential receivers to which the 48 array hydrophones were connected. The 5 watt PC104 processor board includes a 166 MHz Pentium with the usual IDE, serial and parallel functions. It runs W98 DOS, allowing FAT32 usage with large disks. A second PC104 board of our design, referred to as the NAVBOARD, includes functions for real-time clock, acoustic navigation travel time measurements, stack power control, ADC clocking and a watchdog. The timebase is a 5 MHZ Austron oscillator with a stability of a few parts per billion over deployment durations and conditions. A separate, and normally disabled, video board resided in the third PC104 position. A 4-channel Sonatech pulsed tone detector board is used during array element navigation epochs to detect interrogation arrivals.The entire system draws about 27 watts from the battery stack during recording operation.

One TB (terabyte) of disk space can be accessed using four “DISKPAKS” developed for this project, each loaded with eight 32 GB 2.5” drives. The DISKPAK is essentially an IDE backplane accommodating up to eight 25mm height (or smaller) drives, all of which can be electrically disconnected from the IDE bus. From a bank of up to four of these DISK-PAKS, one drive can be selected using a standard 8-bit parallel port. A drive change currently requires a reboot after a new drive has been selected.

The SHARK was configured with three DISKPAKS and twenty-two drives for the South China Sea component of ASIAEX01. Another ten drives were held in reserve for the East China Sea segment, which was ultimately cancelled, however.

The start-up sequence for the SHARK instrument from power up or reset always forces selection of DISK 0. Cold or warm boots retain the currently selected drive. In deployment mode, the video board is disabled to reduce power dissipation. Using the hardwired connection through the endcap, COM1 can be used either strictly as a serial port or as a “CTTY” console. At boot, a query is sent to COM1 allowing a delay of 5 seconds during which CTTY COM1 ops can be invoked by hitting the key sequence “12345”. Barring this, the system does not invoke CTTY and proceeds to run the data acquisition program “ASIAEX”. Among "ASIAEX" command line options are:

-h	show list of command line options, many more than shown here
-showtime	readout RTC time prior to starting data acquisition
-timesync	invoke the RTC sync-to-external PPS edge function
-nodog	Do not use watchdog...if already enabled by previous invocation of “ASIAEX”, this will not disable the DOG
-console	send status info to video card...use of COM1 for status is determined by setting in USER EEPROM
-r	specify COM1 bit rate
-navint	specify interval in seconds between LBL epochs

The program “ASIAEX” will run with or without CTTY; however CTTY should not be invoked unless there is diagnostic intent using the hardwired connection. In either case, status information may be sent to COM1 as data logging proceeds. Console or COM1 output of status at record boundaries can be enabled/disabled by typing the uppercase characters “Q” or “S” respectively. The character “!” will gracefully halt the logging program. The WatchDog forces a power cycle if no data record is written within 60s. The only way to disable this watchdog, once it is started, (it is implemented on the NAV-BOARD), is to either hit the reset button on the NAVBOARD or power cycle the stack from the external umbilical. Neither action disturbs the realtime clock on the NAV-BOARD.

None of the console functionality is advised or particularly useful if the Link Quest acoustic modem is connected to COM1 via the endcap bulkhead connector because of the latency of the acoustic link. The wait for a console response (“12345”) is short to prevent the WatchDog from firing during the wait period, which would effectively disable the system. If the watchdog has ever been enabled, even if the acoustic modem was fast enough to gain the console in less than 5 seconds, there is no way to remotely disable the watchdog, so a reboot would occur within 60 sec from the startup.

With the video board enabled, if CTTY is invoked during a boot using COM1 as the console, PCAnywhere can be invoked by running "pca.bat" on both the instrument and the console. This permits code changes without opening the pressure case. "e" (emacs) can be used over the COM1 console link for simple editing.

Prior to deployment, the option -timesync must be invoked to set the RTC synchronized with GPS clock 1PPS output. After sync, the time is displayed on the console (CTTY works) until a key is hit terminating the program. Data acquisition will not start until the program is again invoked without the timesync option.

The program "ASIAEX" defaults to record forty-eight channels at 3255.208Hz (exact sample rate is 5e6/6/256). The channel assignments were arranged to put the VLA channels in positions 0-15, the sixteen outer HLA channels in positions 16-31, and the sixteen inner HLA channels in positions 32-47. CH 0 is the VLA top sensor, CH 15 is the VLA bottom sensor, CH 16 is the HLA sensor most distant from the SHARK sled and CH 47 is the HLA sensor closest to the SHARK sled.

The hydrophone preamps are current mode, and each derive power and transmit signal over a separate pair of twisted conductors. Seven different twist lay lengths are used to minimize crosstalk at the acoustic navigation frequencies of 10-12 kHz. All hydrophones have a sensitivity of -170 dB, linearly handling signals up to an acoustic receive level of 160 dB corresponding to a maximum amplitude at the differential receiver of about 1 Vpp (-10dBV rms). The receiver applies a fixed gain of 20 dB to each channel. The amplitude match among channels is approximately +/- 1 dB. All channels are sampled on a common timebase, simultaneously, with a constant group delay of 28 samples. The amplitude response is flat to .375*sample rate (1221 Hz) and the -3dB point is .41*sample rate (1335 Hz). The sampling elements are sigma-delta converters of 24 bit resolution with about 21 bits of dynamic range. The 24 bit sample values are converted on the fly to 16 bit values comprised of a 13 bit mantissa, sign bit and 2 bit gain word. The gain bits represent the position in the raw 24 bit word of the most significant 13 bits used as the mantissa. This encoded format is identical to that used on the PRIMER series data sets.

The intention is to sample continuously from the time the system is started until the system is manually halted or exhausts space on the current disk drive. At such a juncture, the full drive is deselected and powered down. The next drive, presumably empty, is powered and selected. The system is rebooted and the acquisition process is restarted immediately. The discontinuity in the data should normally be about 35 seconds. There is no attempt to synchronize these disk changes to anything...they should occur either because data has accrued to within a few megabytes of full or some problem with the disk has forced the switch to another.

The nominal storage rate is 312,500 bytes/s, 1.125GB per hour, 28 GB/day. In addition to the data files, two different types of log files are stored. Similar to the data format for past experiments, data on a given disk are written in a series of seamlessly connected files, each of which consists of 200 records of 1,573,888 bytes each, including a 1024 byte record header, for a size of 314,777,600 bytes representing about 17 minutes. Each record consists of 16384 samples from each of 48 channels and is preceded by the 1024 byte record header (DRH). The data in each record are demultiplexed in the sense that the first 16384 samples (32768 bytes) are from ch 0, the next 16384 samples are from ch 1 and so forth. A data record will be of the following form:

DRH <1024 bytes>

VLA chan 0 value, chan 1 value, chan 2 value, ... chan 15 value, HLA chan 47 value, etc., an integral number of scans as well as 1024 byte blocks

DRH <1024 bytes>

VLA chan 0 value, chan 1 value, chan 2 value, ... chan 15 value, HLA chan 47 value, etc., an integral number of scans as well as 1024 byte blocks

.

.

.

EOF

Data filenames are of the form mmddhhnn.csd, where mm = month, dd = day, hh = hour & nn = minute UTC. Hence, a filename approximates the start time of the first record in the file to the minute. Data records are always 1537 KBytes in length, which includes the 1024 byte DRH. DRH information includes record number, time to the microsecond of the start of the record and engineering data, some of which is in both binary and ASCII form so it's possible to "figure out" where one is by viewing an ASCII representation of a DRH. Acoustic LBL navigation data is recorded in the DRH closest in time to the occurrence of the end of the NAV cycle. It is also logged in the log file having the same name as the data file but extension ".csl". Finally all NAV data acquired during the time a disk is online are logged in a single ASCII file of the name LBLNAV.csn.

Data are stored as unsigned short int (2 bytes), with the lower byte occurring first followed by the upper byte. The bits are high true, i.e an active bit is a "one" or high logic level. The 16 bit sample consists of a 14 bit, 2's complement mantissa (M12 is msb), in the low part of the word, with the 2 gain bits in the lower part, (G1 is msb). The sign bit is in the 15th bit position, (0 is positive). Bits 0 through 7 are the low byte and bits 8 through 15 are the high byte of the stored sample. The exponent represents effective gains of 1, 8, 64 & 512 with 00, 01, 10, & 11 respectively. These correspond to left shifts of 0, 3, 6 & 9 bits in the raw 23 bit magnitude.

Bit 15 14 13 12 11 10 09 08 07 06 05 04 03 02 01 00

```
SN m12 m11 m10 m09 m08 m07 m06 m05 m04 m03 m02 m01 m00        G1  G0
{+/-}{            13 BIT MANTISSA                     }        {`GAIN'}
```

There are always 16384 - 47 channel scans in a record. Following the last block of a record will be the next DRH, followed by more data. Time to the microsecond of the first sample in any record and the record number are recorded in the record header as shown in the “C structure” used to define the 1024 byte Data Record Header (DRH). The start time value wobbles about some (usually only a few microseconds), due to the interrupt response time of the acquisition system. Note that number types are from the PC world where “ints” are shorts, 2 bytes, and “longs” are 4 bytes.

```
struct  data_rec_hdr                            // 1024 bytes total
{
        unsigned char   rhkey[4];               // header key, "DATA"
        unsigned int    date[2];                // date[0]=year, date[1]=Year-day#
        unsigned in     time[2]                 // time[0] = (hours*60 + minutes)
                                                // time[1] = (seconds*1000 + milliseconds)
        unsigned in     microsec;               // microseconds
        unsigned in     rec;                    // number of record that follows

        unsigned int    ch;                     // # channels  <48>
        long            npts;                   // sample periods per record <16384>
        float           rhfs;                   // sample rate in Hz <3255.208>
        unsigned int    rlen;                   // rec length in blocks, includes DRH <1537>
        long            rectime                 // record time in microsec <5033165>

        char            rhlat[16];              // N/A
        char            rhlng[16]               // N/A

        unsigned long   nav120[7][8];           // for SCS LBL nav, 224 bytes
        unsigned long   nav115[7][8];           // for SCS LBL nav, 224 bytes
        unsigned long   nav110[7][8];           // for SCS LBL nav, 224 bytes

        unsigned int    navmh;                  // time of first ping of this LBL suite
        unsigned int    navmss;
        int             lblnav_flag;            // non-zero indicates that LBL data is valid
        unsigned char   unused1[42];            // not used for SCS-2001

        char            internal_temp[16];      // n/a
        char            bat_voltage[16];        // n/a
        char            bat_current[16]         // n/a
        unsigned char   status[16];             // for AD24 status bytes if marker bit err

        char            proj[16];               // project name, ascii  <SOUTH CHINA SEA>
        char            aexp[16];               // N/A
        char            vla[16];                // VLA sensitivity  <-170 db>
```

```
        char            hla[16];            // HLA sensitivity  <-170 or 0 if not used>

        char            fname[16];          // ascii file name  <mmddhhnn.csd>
        char            record[16];         // ascii representation of rec #, REC ####
        char            adate[16];          // ascii representation of date, mo/da/yr
        char            atime[16];          // ascii rep of rec time, hr:mn:ss.mmmmmm

        char            unused2[8];
        int             adc_rate_code;      // AD24 rate code, {6,5,4,3,2,1,0} <6>
        int             adc_mode;           // 0 =fixed point, 1 = 24 bit, <2 = pfp>
        int             adc_clk_code;       // timebase divider to get AD24 clock <6>
        unsigned int    scan_blocks;        // # 512 pt scans per AD24      <32>

        long            timebase;           // 5 MHz
        long            xbuf_size;          // extended memory space in use
        long            wr_xbuf;            // linear address of first xm buffer, this record
        long            rd_xbuf;            // linear address of data buffer, this rec

        unsigned int    xm_block_size;      // size of block transfers to xm space/intr
        unsigned int    xmbufs;             // # xmspace buffers
        unsigned int    xbufs_per_rec;      // # xm_block_size blocks per record
        int             buf_avail;          // xmbufs currently full, waiting to be written
        char            ovf;                // data buffer overflow count
        char            tbufs;              // # time buffers  /
        char            ip_flag;            // input buffer #
        char            op_flag;            // output buffer #
        char            rhkeyl[4];          // end of rec header key "DATA"
};                                          //
```

Sample rate is a function of the Delta-Sigma ADC architecture and the ADC clock. There was no intention of changing this prior to deployment, but the following table shows sample rate selections with 48 channels. ASIAEX-2001 data was sampled at 3255.208 Hz. The base clock rate from the Austron crystal is 5 MHz.

"n"	CLK, (KHz)	O/P_Rate	-3dB BW	BW(flat)	ADC Rate Code	#CH	Tx_BW (B/s)	32GB Disk (hrs)
4	1250000	610	250	229	3	48	58594	151
		1220	500	457	4	48	117188	75
		2441	1001	915	5	48	234375	37
		4883	2002	1831	6	48	468750	18
5	1000000	488	200	183	3	48	46875	189
		976	400	366	4	48	93750	94

"n"	CLK, (KHz)	O/P_Rate	-3dB BW	BW(flat)	ADC Rate Code	#CH	Tx_BW (B/s)	32GB Disk (hrs)
		1953	801	732	5	48	187500	47
		3906	1602	1465	6	48	375000	23.5
6	833333	407	167	153	3	48	39062	22
		814	333	305	4	48	78125	113
		1627	667	610	5	48	156250	56
		3255	1220	1335	6	48	312500	28

For each data file (extension .csd), there is a companion ASCII log file (extension .csl) on the same drive which contains status information available at the time each record is stored. The acoustic long baseline (LBL) array element navigation data were logged in the ".csl" file as well as the file "lblnav.csn" also on the data drive. All LBL data during the time a disk was being filled was written to the latter file.

An LBL epoch should occur every 10 minutes starting on the hour. In contrast to past VLA systems we have done, the interrogator for this system is at the end of a 100m extension beyond the outboard end of the HLA to eliminate overloading of the VLA sensors. The interrogator is an OIS transponder modified to be fired with an external "switch closure", which is generated by the recording instrument in the SHARK sled. It is optically coupled at the recording instrument. The interrogator will operate as a transponder, as will the OIS unit in the SHARK sled during survey ops conducted from the ship. The RECEIVE frequency of these OSI transponders is 10.5 KHz. The TRANSMIT frequencies of the interrogator and SHARK transponders are 11.5 and 9.5 kHz respectively. Two Benthos releaseable transponders were used along with the interrogator to localize array elements. They both receive at 11.5 kHz and reply at 12.0 and 11.0 kHz. The source level of the Benthos units is about 191 dB, while the OIS source level is more like 188 dB.

The sensors' sensitivities are about -172dBV at 10 kHz. At the front end of the recording system receivers, there is a broadband fixed gain of 20 dB followed by 12 dB of attenuation on the LBL signal tap. Seven array channels have been selected for LBL, M0 - M6. The correspondence with array channel numbering is:

M0 = CH 0	top of the VLA
M1 = CH 6	22.5m from ch 0
M2 = CH 10	42.25m from ch 0
M3 = CH 13	63.75m from ch 0
M4 = CH 16	nominally 467m from sled
M5 = CH 26	nominally 317m from sled
M6 = CH 36	nominally 167m from sled

Crosstalk measurements were made using the 472m SCS HLA cable in air, which showed that at 12 kHz, with CH 0 driven to provide +5.3 dBV at the AD620 diff amp outputs on AD24 boards, crosstalk levels at the output of CH 16 - CH 31 ranged from -89 to -97 dBV corresponding to an attenuation level range of -94 to -102 dB. Measured crosstalk levels using a CW signal, observed at the AD24, AD620 amplifier outputs were:

CH 0	+5.3dBV (driven channel)
CH 1	-93
CH 2	-98
CH 3	-89
CH 4	-97
CH 5	-97
CH 6	-95
CH 7	-92
CH 8	-95
CH 9	-96
CH 10	-95
CH 11	-94
CH 12	-94
CH 13	-95
CH 14	-95
CH 15	-94

By the time these signals propagate through the multiplexor on the NAVBOARD, to the Sonatech detector board, with AD24 +12VDC supplied to the Sonatech board, the net crosstalk levels were more a function of contamination in the instrument than in the cable, at this length. Measurements at the AD24 LBL output buffers showed the following:

CH 0	-6.8 dBV (driven channel)
CH 1	-95
CH 2	-94
CH 3	-96
CH 4	-95
CH 5	-91
CH 6	-94
CH 7	-94

The Sonatech detector board was configured to use transformer coupled analog inputs and optically coupled digital outputs. Using an independent 12V battery to run the Sonatech board, crosstalk rejection at LBL frequencies was at least 90 dB. At a range of 500m, a Benthos transponder will generate an output level of -33dBV from the -170dB sensors. Coupled with 90 dB of rejection at the input of the Sonatech board this results in a crosstalk signal comparable to the Sonatech's minimum detection signal level.

LBL data are stored as 4-byte longs in microseconds and represent, in the case of the 11.5 kHz detections, the traveltime measurement from the interrogator at the HLA tail to any of the 7 LBL sensors plus the detection and reply delay of the Sonatech detectors. In the case of the two Benthos transponders, LBL measurements represent the traveltime from the interrogator to the transponder, the traveltime from the transponder to the selected array channel and the detection and reply delays of both the transponder and Sonatech detectors. Hence, traveltimes between the interrogator and array elements include about 4ms of delay from the Sonatech. Traveltimes from interrogator to transponder to detection output have a net delay of about 12ms

	Detection delay	reply delay	jitter
Benthos transponder................	6 ms	2ms	+/- 200 us
OIS transponder/interrogator....	6 ms	2ms	+/- 200 us
Sonatech...................................	4		+/- 200 us

The realtime clock in the SHARK was synchronized to UTC provided by the Arbiter GPS disciplined clock. As usual, prior to deployment the time offset is recorded. Subsequent to recovery, the time offset is again measured so that an average clock drift rate can be estimated. There is no way of determining the distribution of this net drift with time. Nor do we have a way of estimating the affect of the temperature change during deployment and recovery. The relationship between Sample_O/P_Rate and BW is:

Sample_O/P_Rate = (CLOCK / 256) / (2**(6-ADC_Rate_Code))

The relationship for flat DATA BW (Hz) and Sample_Rate is:

BW = .375 * Sample_O/P_Rate

The relationship between Flat BW and storage/telemetry rate is:

Telemetry_Rate = (BW / .375) * CHANNELS * 2

The CLK frequency is the Austron 5 MHz output divided by "n".

Data can be normalized to volts at the output of the sensor as follows:

- The 2 bit gain code represents up to 3 - 3-bit left shifts of the original 24 bit ADC word. This can be treated as exponent = 1 << ((stored value & 0x03) * 3).
- mantissa = (value >> 2)} (13 bits and sign bit)
- Differential amp fixed gain = 10
- Full scale digital value of ADC is 5242880. Hence, the factor .625 results from 5242880/(2**23) Full scale ADC input voltage is -4.5
- Hence: normalized value = (4.5 * mantissa)/(2**13)/.625/exponent/10}
- The "C" code used to do this is:

```
exp = 1 << ((p[i]&0x03*3);     /* where p[i] is a raw data value */

fprintf(outfile, "%08f\n", (double)(p[i]>>2)*4.5/8192/exp/.625/gain);
```

4.2 SHARK data backup tape and file naming formats

The acoustics data were transferred from internal SHARK disks to external disks. Nine 75 GB disks were employed to store all 650 GBs of acoustic data. This data was also promptly backed up to Sony AIT2 tapes; one tape per 35GB internal SHARK hard drive. The backup of the data was performed using the standard Unix 'tar' tape archive utility. Windows machines can also freely obtain tar from the web or from ftp://acoustics.whoi.edu/pub/dos if necessary. The command for downloading data from the tape should look like:

tar xvf TAPENAME   with TAPENAME being the tape device

All data files are named according to their starting data and time MMDDhhmm.CSD, where MM is month, DD is day, hh is hour, and mm is minute. The extension CSD stands for SHARK data. Any files with extension .CSN contain navigation data. A full acoustics data file should contain 314777600 bytes. Over 1600 files were retrieved. See appendix 9.1 for listings of all files.

A few data files had DOS FAT (file allocation table) problems, probably due to the 'watchdog' reboot and not being able to close the files beforehand. Most of these files were fixed with standard utilities upon return and backed-up at WHOI. These new files, as well as the originals, are included on the tapes. Table 39 lists all the data files that were repaired.

TABLE 39. SHARK acoustics data files that needed repair.

05120143.csd	05050242.csd
05121436.csd	05060849.csd
05031639.csd	05060922.csd
05041158.csd	05130743.csd
05031639.csd	05140126.csd
05041158.csd	05140736.csd
05160407.csd	05161006.csd

SHARK data disks 0-13 were near total capacity. Disks 14-23 were at partial capacity. Disks 8 and 12 were not used.

Copies of this data can be obtained, with permission, from Dr. Ching Sang Chiu at the Naval Postgraduate School.

5.0 SHARK VLA/HLA preliminary array element navigation

SHARK long baseline localization (LBL) and bulb drop navigation was used for determining hydrophone positions on the horizontal line array elements. From the LBL calculated placements, it appears that the array changed positions frequently during the experiment. The light bulb sources give the array positions on May 5th and May 15th. The configurations determined by the LBL navigation and the bulb drops for those two dates are shown in Figures 27 and 28.

Table 40 lists the hydrophone configuration calculated from the bulb sources on May 5. Table 41 lists the configuration for May 15. For the LBL receptions, it was first necessary to determine if the LBL transmission path was either surface bounce or direct. It was then possible to calculate the ranges to the LBL receiver channels using a depth averaged sound speed. These ranges from each of the three navigation transponders were then used in a least squares calculation to determine the LBL receiver channel positions (hydrophones 16, 26, and 36). The positions from the lightbulb drops were calculated in a similar manner. Three lightbulb receptions were used on May 5 and five good receptions were used on May 15.

TABLE 40. HLA hydrophone positions from lightbulb sources for May 5th.

Hydrophone	latitude N	longitude E
16	21 52.686	117 10.918
17	21 52.693	117 10.918
18	21 52.700	117 10.922
19	21 52.706	117 10.927
20	21 52.712	117 10.932
21	21 52.716	117 10.939
22	21 52.720	117 10.947
23	21 52.722	117 10.955
24	21 52.724	117 10.964
25	21 52.725	117 10.972
26	21 52.726	117 10.981
27	21 52.726	117 10.990
28	21 52.725	117 10.999
29	21 52.724	117 11.007
30	21 52.722	117 11.015
31	21 52.720	117 11.024
32	21 52.719	117 11.032
33	21 52.726	117 11.036
34	21 52.732	117 11.040
35	21 52.737	117 11.045
36	21 52.743	117 11.047
37	21 52.751	117 11.047
38	21 52.758	117 11.048
39	21 52.765	117 11.051
40	21 52.772	117 11.054
41	21 52.779	117 11.057
42	21 52.786	117 11.059
43	21 52.794	117 11.061
44	21 52.801	117 11.063
45	21 52.808	117 11.067
46	21 52.814	117 11.073
47	21 52.818	117 11.080

TABLE 41. HLA hydrophone positions from lightbulb sources for May 15th.

Hydrophone	latitude N	longitude E
16	21 52.679	117 10.901
17	21 52.680	117 10.909
18	21 52.683	117 10.917
19	21 52.688	117 10.923
20	21 52.693	117 10.929
21	21 52.699	117 10.934
22	21 52.705	117 10.939
23	21 52.711	117 10.944
24	21 52.717	117 10.949
25	21 52.724	117 10.953
26	21 52.730	117 10.958
27	21 52.736	117 10.963
28	21 52.742	117 10.968
29	21 52.749	117 10.972
30	21 52.755	117 10.976
31	21 52.762	117 10.979
32	21 52.769	117 10.983
33	21 52.776	117 10.988
34	21 52.782	117 10.994
35	21 52.787	117 10.999
36	21 52.792	117 11.006
37	21 52.791	117 11.012
38	21 52.792	117 11.019
39	21 52.791	117 11.028
40	21 52.790	117 11.036
41	21 52.792	117 11.044
42	21 52.795	117 11.052
43	21 52.800	117 11.060
44	21 52.805	117 11.066
45	21 52.811	117 11.070
46	21 52.817	117 11.074
47	21 52.819	117 11.080

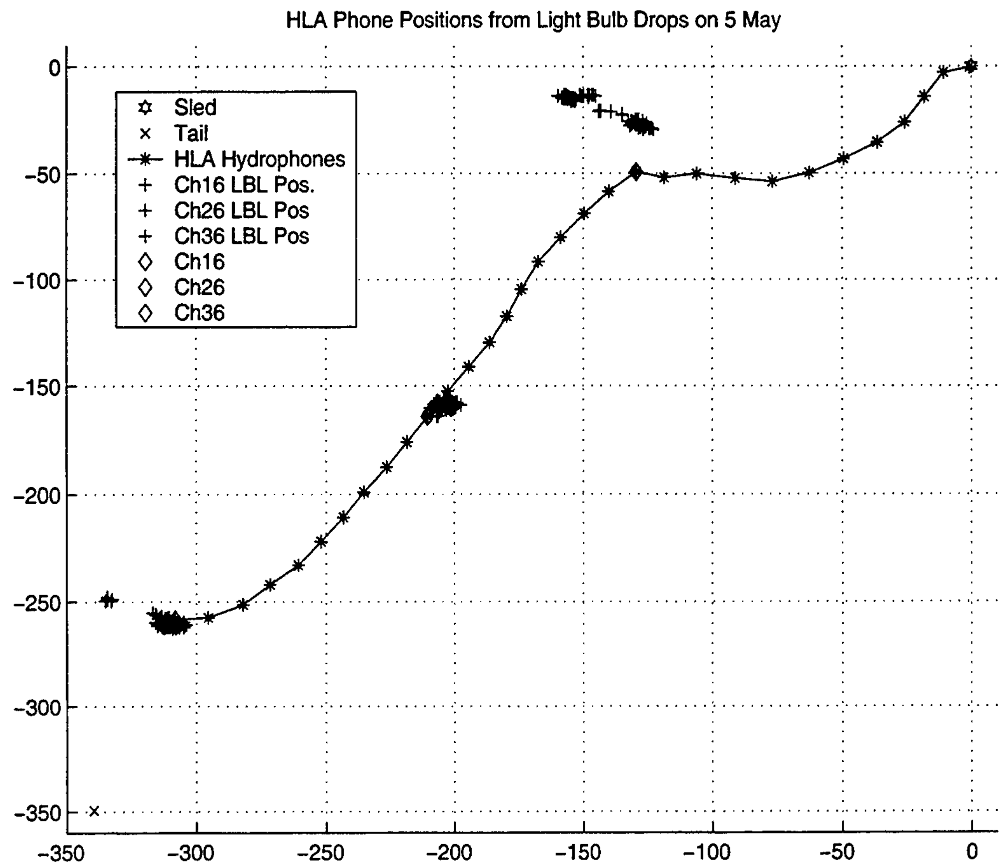

FIGURE 27. HLA array element positions from LBL and bulb drops for May 5th. Note good overall agreement of the two techniques.

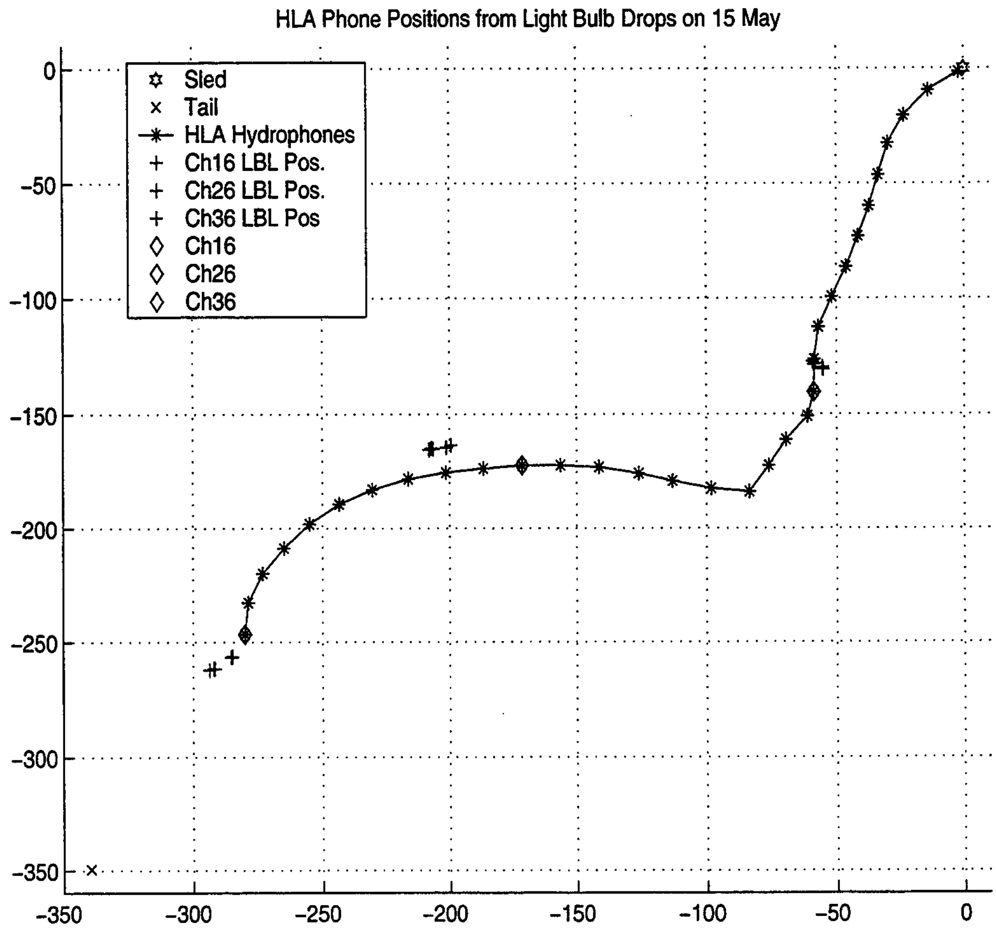

FIGURE 28. HLA array element positions from LBL and bulb drops for May 15th. Again, good agreement of the techniques is noted.

6.0 Bathymetry

Bathymetric data from four cruises have been interpolated onto a grid. The interpolated data are shown in Figure 29. Data are from *OR3*, cruise 651, and *OR1* cruises 609, 610 and 611 of the 2001 ASIAEX study. Ship tracks of these cruises are shown in the color gray. Cruise OR3-651 of 16-20 September 2000 was headed by Dr. R.-C. Wei of National Sun Yat-sen University. Cruise OR3-651 purposely densely sampled a rectangular area which follow the approximate headings of 165 and 345 degrees. Data are sparse outside of this region, where only a few *OR1* tracks constrain the bathymetry, and where depths must be interpolated between these tracks.

The area is seen to be relatively flat to the north, with a steep cliff-like transition at 140 m depth dropping to 220 m. This steep transition between 140 and 220 meters does not always occur; note that it is absent along the westernmost Seasoar track (cruise 610, dotted) and at the position of the three shallow acoustic sources.

Both the along shore and across-shelf propagation track bathymetries were also surveyed with a high resolution chirp sonar system. These data will be discussed in another report by the Florida Atlantic University (FAU) investigators.

The locations of recovered moorings are also shown in Figure 29. Acoustic sources and receivers are green, Loco moorings are pink, other environmental moorings are red, and the Panda receiver is blue. The environmental mooring at 792 m depth is not shown.

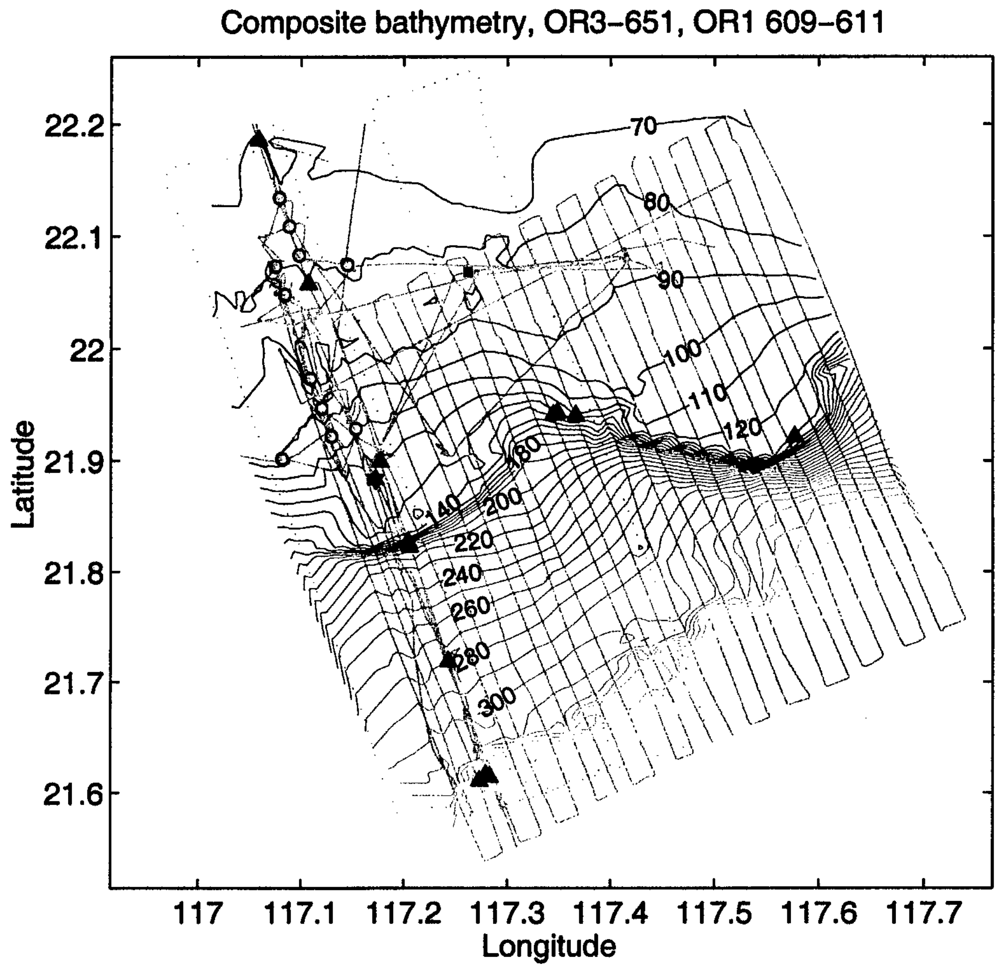

FIGURE 29. Bathymetry for the South China Sea 2001 Experiment from *OR3* cruise in 2000, and SeaSoar and *OR1* cruises in 2001,

7.0 Environmental mooring information

WHOI was responsible for many of the environmental moorings deployed in the ASIAEX SCS experiment. Some of the details of those moorings are given here. Further details will be found in other reports, particularly those by S. Ramp and C.S. Chiu of the Naval Postgraduate School (NPS), who deployed and recovered many of them from the *OR1*.

7.1 Locomoor array

The standard environmental moorings composed of heavy-duty instrumentation, wire rope, steel and glass flotation, and large anchors, were supplemented by eighteen subsurface 'Locomoors' (Low-Cost Moorings). The Locomoors were composed of a float module, a polyester rope, and a 933 pound iron anchor. They had no surface expression, so as to prevent human interference. Their maximum deployment depth was 120 m due to the light construction used. The mooring configuration is shown in Figure 30.

The Locomoors were intended to provide dense spatially measurements of the evolving nonlinear internal waves and internal wave packets. In addition to measuring the time-history of propagating waves by giving repeated estimates of wavelength and amplitude, the Locomoor array also acted as an antenna, giving the speed and direction of these waves.

Each Locomoor carried three instruments. Uppermost was a Seabird SBE39 temperature/ pressure recorder. Below that were two Star-Oddi Starmon-mini temperature recorders. The SBE39 pressure sensor provided monitoring of mooring pull-down by currents. The sensor serial numbers and depths are listed in Table 40. All sensors had plastic pressure cases and were taped and cable-tied to the rope. Each float module had eight high-impact plastic spheres assembled together within an aluminum frame. Within the frame there also was a canister holding a recovery line attached to two additional spheres. At recovery time, the two spheres and line were to be sent to the surface by an acoustic release command.

Of the eighteen Locomoors, eleven were recovered and seven were lost. Of the recovered systems, one had rope that was too long so the float was at the surface, four were recovered acoustically, and six were recovered by a SCUBA diver hooking an auxiliary recovery line to the mooring. One of those six had been damaged and had no recovery floats; the other five had acoustic release failures. Three of the recovered floats were damaged, with bent or cut aluminum. All of the thirty-three recovered instruments provided data. Launch positions and times are presented in Table 43.

TABLE 42. Locomoor sensor information.

Mooring	Instrument	depth (m)	Sampling interval (minutes)
Loco 1	SBE39 0320	14	0.5
	T-0266	24	1
	T-0267	44	1
Loco 2	SBE39 0327	16	0.5
	T-0263	26	1
	T-0250	46	1
Loco 3	SBE39 0324	13	0.5
	T-0249	23	1
	T-0224	43	1
Loco 4	SBE39 0322	15	0.5
	T-0223	25	1
	T-0222	45	1
Loco 5	SBE39 0326	15	0.5
	T-0221	25	1
	T-0256	45	1
Loco 9	SBE39 0313	22	0.5
	T-0212	27	1
	T-0289	47	1
Loco 11	SBE39 0318	22	0.5
	T-0290	27	1
	T-0257	37	1
Loco 13	SBE39 0242	27	0.5
	T-0279	37	1
	T-0282	47	1
Loco 14	SBE39 0311	28	0.5
	T-0283	38	1
	T-0284	48	1
Loco 15	SBE39 0317	26	0.5
	T-0220	36	1
	T-0219	46	1
Loco 16	SBE39 0243	30	0.5
	T-0218	40	1
	T-0217	50	1

TABLE 43. Launch positions and times for Locomoor moorings.

mooring	Latitude N	Longitude E.	Depth (m)	Deployed (UTC)	Recovered (UTC)
Loco1	21 55.705	117 9.183	109	0134 22 Apr	2236 20 May
Loco2	21 55.305	117 7.761	104	0300 22 Apr	0813 21 May
Loco3	21 54.100	117 4.861	101	0418 22 Apr	1006 18 May
Loco4	21 56.814	117 7.185	99	0514 22 Apr	0300 22 May
Loco5	21 58.400	117 6.534	93	0550 22 Apr	0103 21 May
Loco9	22 2.871	117 5.016	85	1110 22 Apr	0520 21 May
Loco11	22 4.378	117 4.471	81	1520 22 Apr	0000 20 May
Loco13	22 8.04	117 4.707	75	1658 22 Apr	0743 17 May
Loco14	22 6.519	117 5.292	76	1751 22 Apr	0245 20 May
Loco15	22 4.973	117 5.861	79	1830 22 Apr	0522 20 May
Loco16	22 4.474	117 8.679	80	2010 22 Apr	0824 20 May

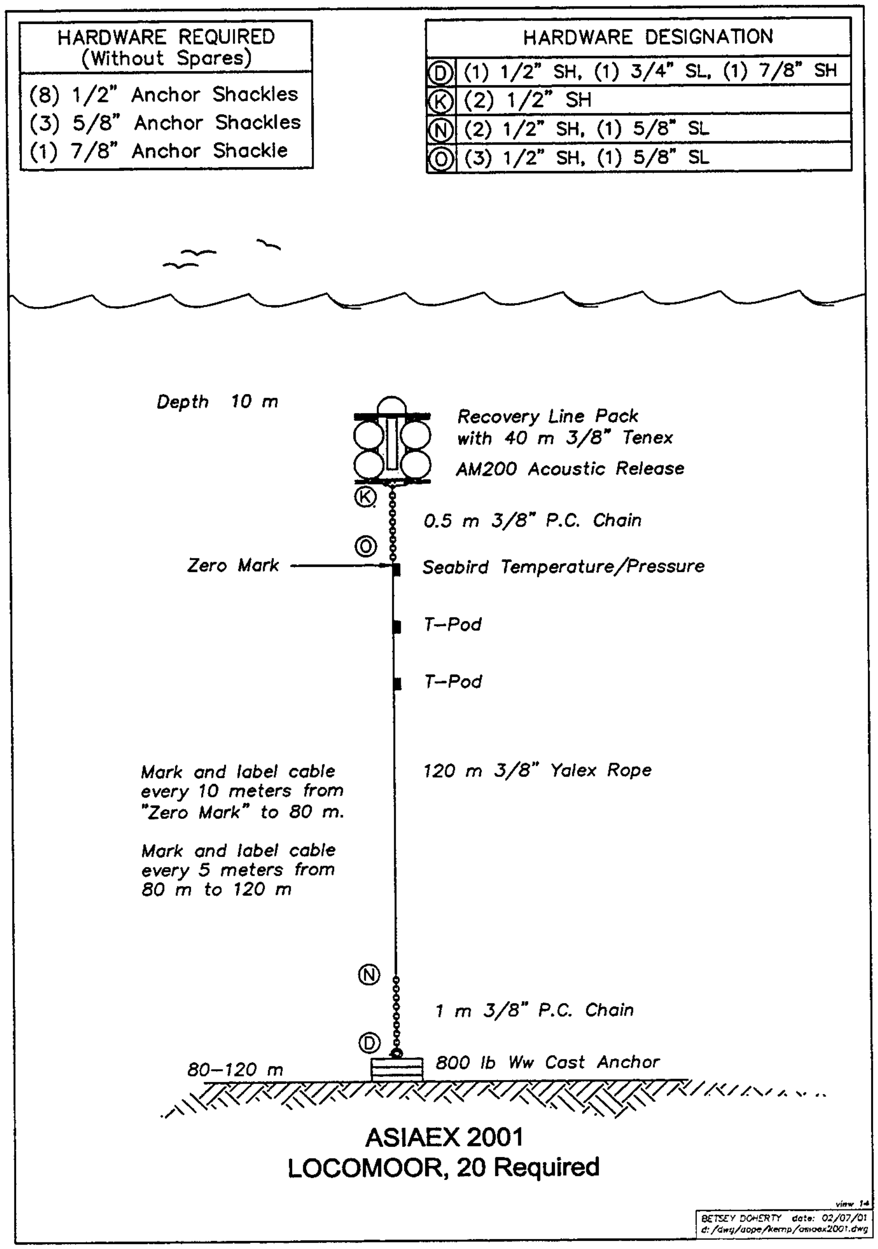

FIGURE 30. Locomoor mooring configuration.

7.2 Temperature/current moorings

In addition to the dense Locomoor array, a well instrumented cross-shelf line of oceanographic moorings was also deployed from the *OR1*, with sensors measuring temperature, salinity, current, and pressure. The locations, depths, and deployment/recovery times of these instruments are given in Table 44. Two thermistor strings were employed off this line in the along-shelf direction; one near the shallow sources and one at a deeper, remote site. More information about these thermistor strings can be found in section 3.6.

In Table 45, the individual instruments on each environmental mooring are described. Please note that the SBE26 pressure sensors had 2 sampling modes: one sample every 5 minutes and a burst sample for 2 consecutive minutes twice a day. The moorings which emphasize ADCP's are described in Table 46. Diagrams of these environmental moorings are shown in Figures 31-36.

TABLE 44. Launch positions and times for temperature/current moorings. The T-string data is discussed in section 3.6.

mooring	Latitude N	Longitude E	Depth	Deployed (UTC)	Recovered (UTC)
ADCP-71	22 11.14	117 03.49	71	1922 20 Apr	0645 17 May
env-85	22 03.445	117 06.423	85	1350 20 Apr	0440 5 May *
env-120	21 53.944	117 10.619	120	1049 21 Apr	0800 19 May
ADCP-184	21 49.616	117 12.240	184	0640 21 Apr	0945 18 May
env-200	21 49.346	117 12.328	202	0751 21 Apr	0909 18 May
ADCP-275	21 43.24	117 14.60	275	0417 21 Apr	0710 18 May
env-350	21 36.871	117 16.975	350	0217 21 Apr	0050 19 May
ADCP-800	20 53.00	117 33.99	792	1922 23 Apr	0850 21 May
T-string #307	21 56.357	117 21.290	111.7	0054 30 Apr	0235 20 May
T-string #598	21 55.193	117 34.609	139.0	0126 03 May	0025 20 May

* - recovery date denotes when mooring was broken due to fishing activity.

TABLE 45. *OR1* Environmental mooring instrumentation.

Mooring	Instrument	Serial Number	Depth (m)	Sampling Interval (minutes)
env-85	Microcat+P	792	14	1
	Mini-T (no data)	C296	22	2
	Mini-T	T-0254	32	1
	Microcat	1133	42	
	Mini-T (detached,lost)	D772	52	2
	Mini-T (detached,lost)	D773	62	2
	Microcat	458	72	1
	300 KHz RDI BBADCP	894	77	1
	SBE26Pressure	249	79	5 single 720 burst
	Mini-T	C310	81	2
env-120	SBE 39 TP	321	11	0.5
	Mini-T	T-0271	19	1
	Mini-T	C956	29	2
	Microcat	798	39	1
	Mini-T	C283	49	2
	Mini-T	D778	59	2
	Microcat	1137	69	1
	Mini-T	D784	80	2
	Mini-T	D795	90	2
	Microcat	1138	100	1
	300 KHz RDI BBADCP	57	104	1
	Mini-T	C963	117	2
env-200	Microcat+P	1770	14	1
	Mini-T	C655	22	2
	Mini-T	C934	42	2
	Microcat	1139	62	1
	Mini-T	C935	82	2
	Microcat	1140	102	1
	Mini-T	C936	122	2

TABLE 45. *OR1* Environmental mooring instrumentation.

Mooring	Instrument	Serial Number	Depth (m)	Sampling Interval (minutes)
	Microcat			1
	Mini-T	C948	162	2
	Microcat	715	182	1
	Mini-T	C951	199	2
env-350	Microcat+P	794	20	1
	Mini-T	T-0272	40	1
	Mini-T	T-0273	60	1
	Mini-T	T-0274	80	1
	Seacat	2098	100	1
	300 KHz RDI BBADCP	125	100	1
	Mini-T	T-0275	120	1
	Microcat+P	0799	140	1
	Aanderra RCM8	9258	150	2
	Mini-T	T-0276	160	1
	Mini-T	T-0278	180	1
	Microcat	1132	200	1
	Aanderra RCM8	9259	210	2
	Mini-T	D720	220	2
	Mini-T	D721	240	2
	Microcat	1134	260	1
	Mini-T	D722	D722	2
	Mini-T	D724	300	2
	Aanderra RCM8	9260	310	2
	Seacat	2359	320	1
	SBE26 Pressure	306	344	5 single 720 burst
	Mini-T	D726	346	2

TABLE 46. *OR1* ADCP mooring instrumentation.

Mooring	Instrument	Depth (m)	Sampling Interval
ADCP-71	RDI BB ADCP S/N 0143 w/ temperature and pressure	71	2
ADCP-184	150 KHz RDI NB ADCP	177	2
	Mini T D727	180	2
ADCP-275	RDI BB ADCP	238	2
	Seacat CTP SN 3100	243	2
ADCP-800	RDI BB ADCP	208.5	2
	Seacat CTP SN 1549	213.5	2

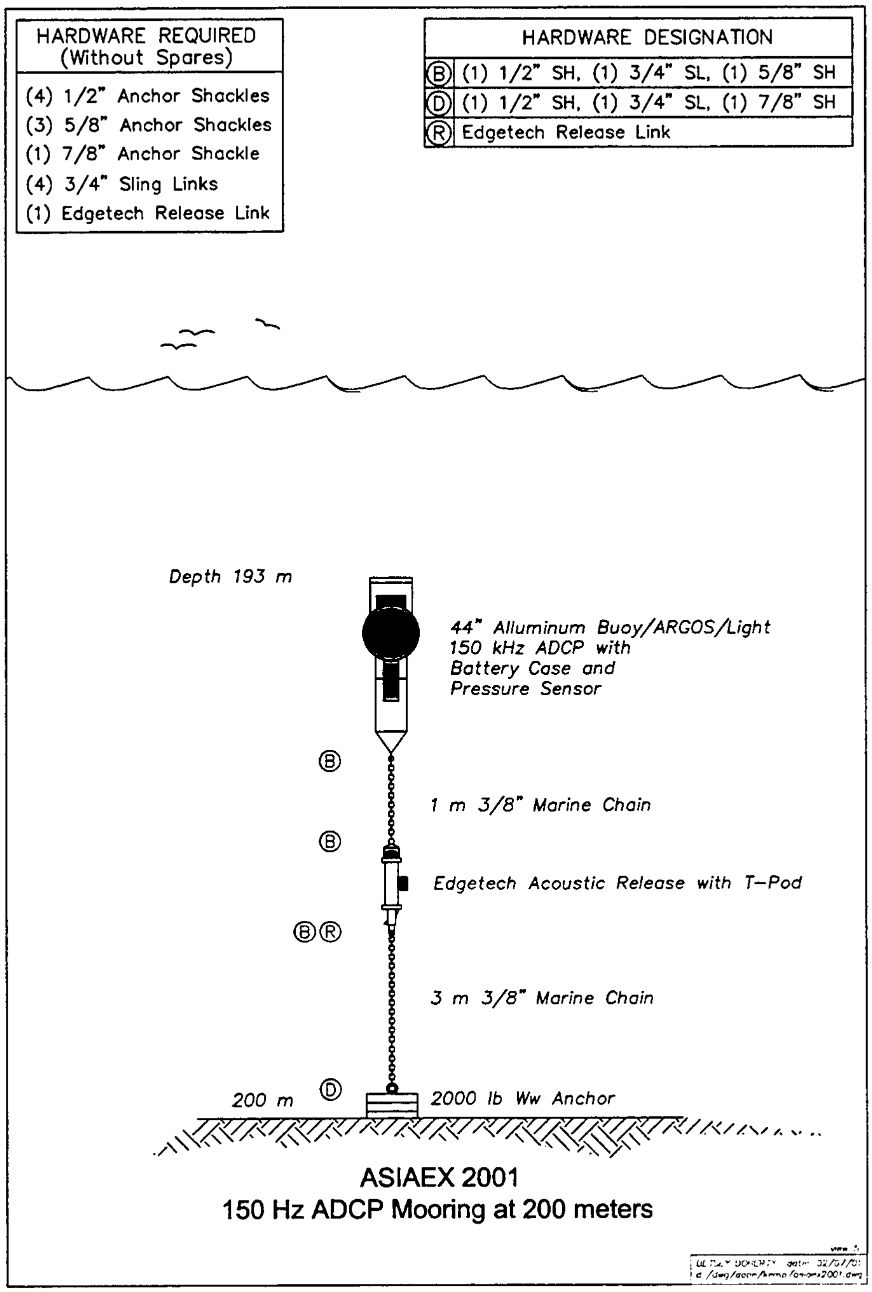

FIGURE 31. ADCP mooring configuration (mooring 5). The actual deployment was at 184 meters.

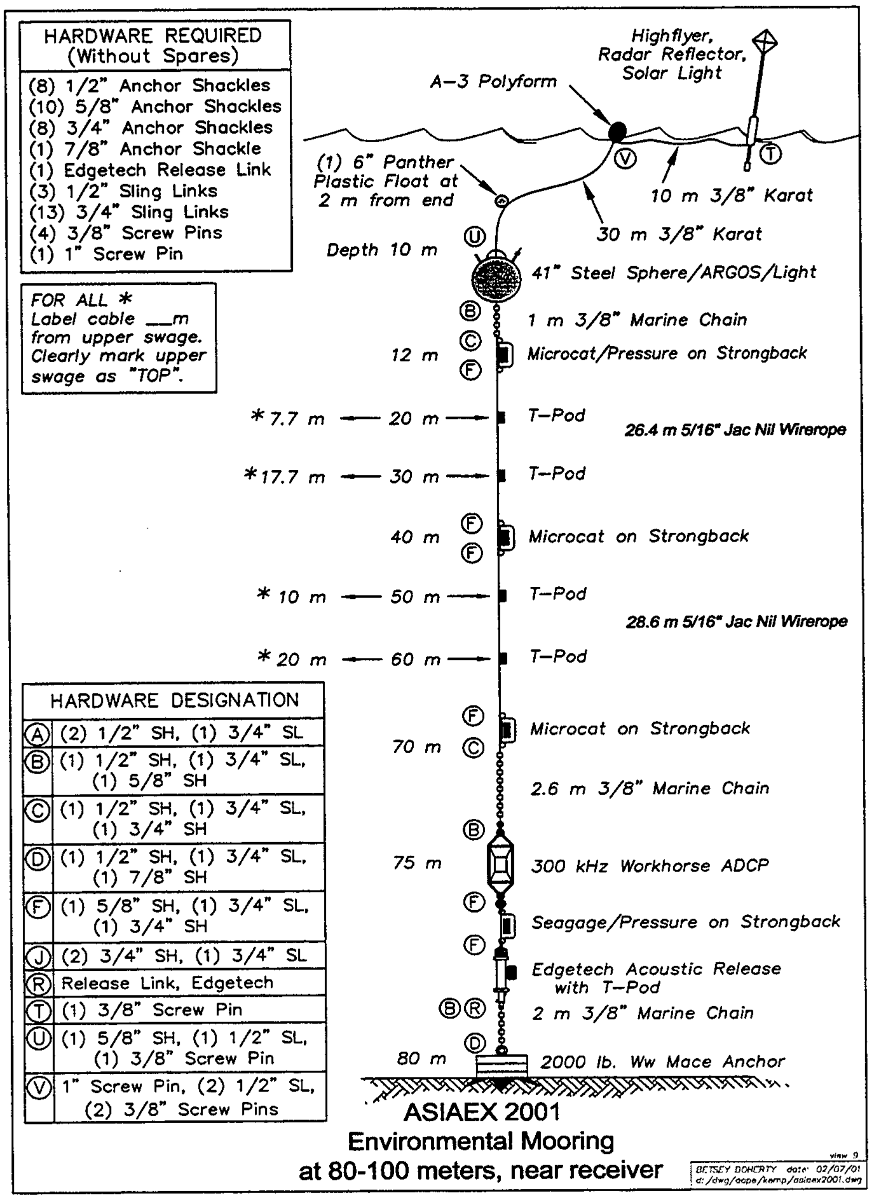

FIGURE 32. Configuration of the environmental mooring at 85 meters (mooring 9). Actual sensor depths are given in Table 45.

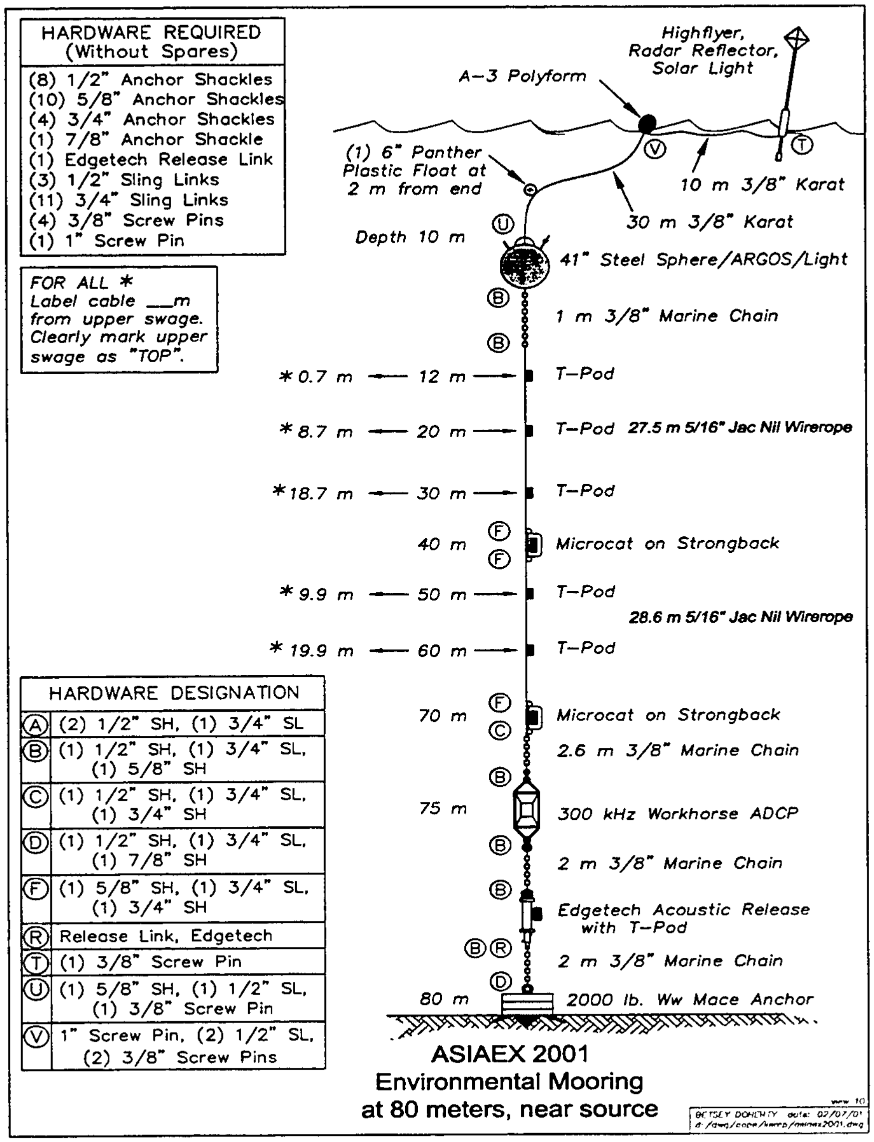

FIGURE 33. Configuration of nvironmental mooring at sources location (mooring 10). This mooring was broken were lost, resulting in no data.

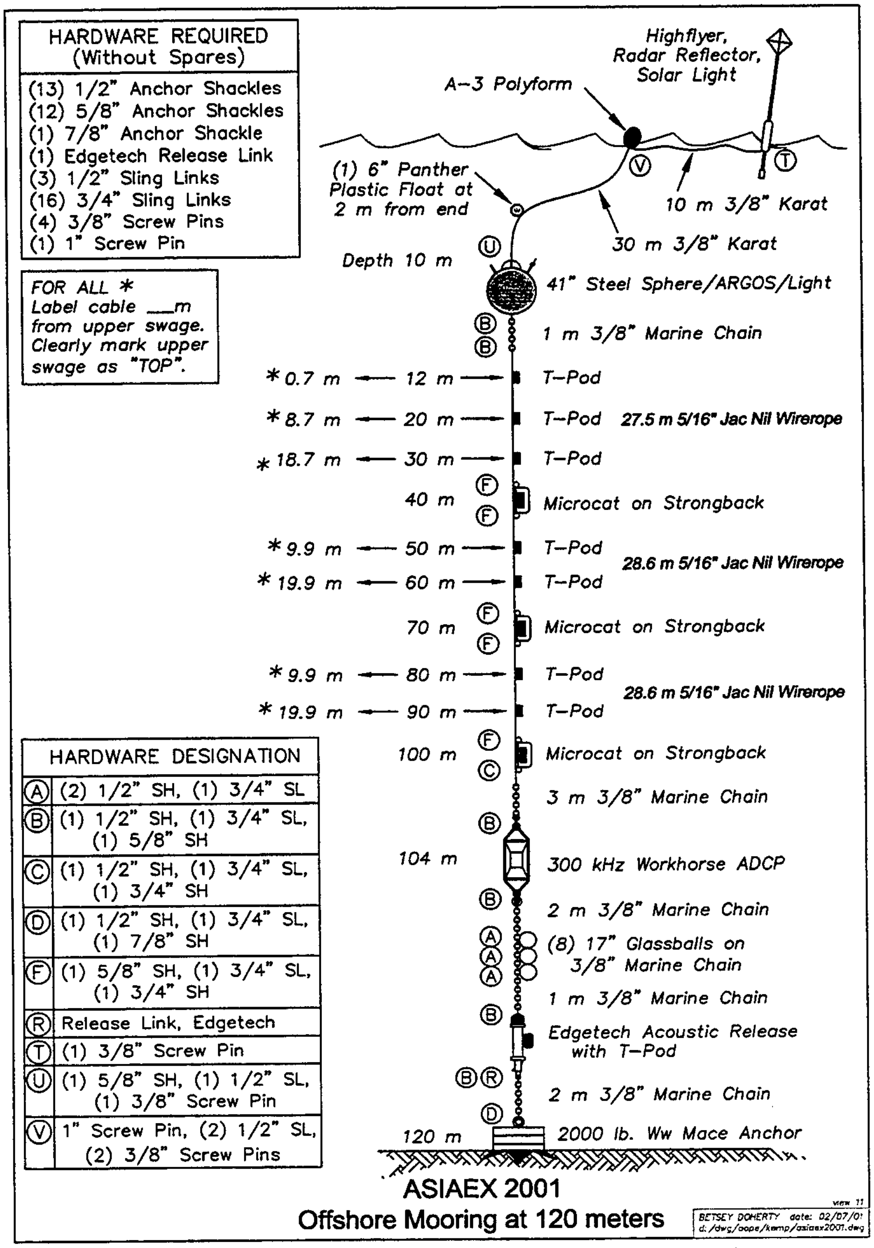

FIGURE 34. Environmental mooring at 120 meters configuration (mooring 11).

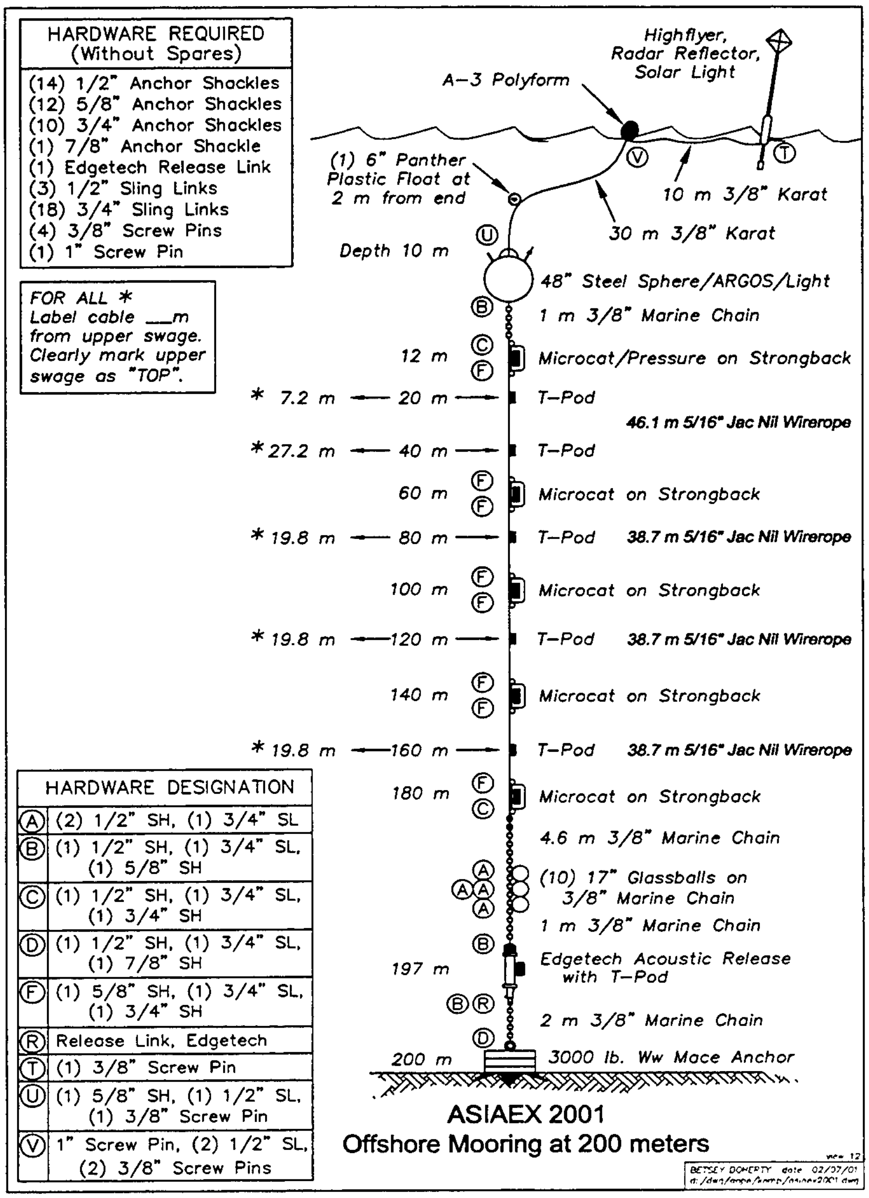

FIGURE 35. Environmental mooring at 200 meters configuration (mooring 12).

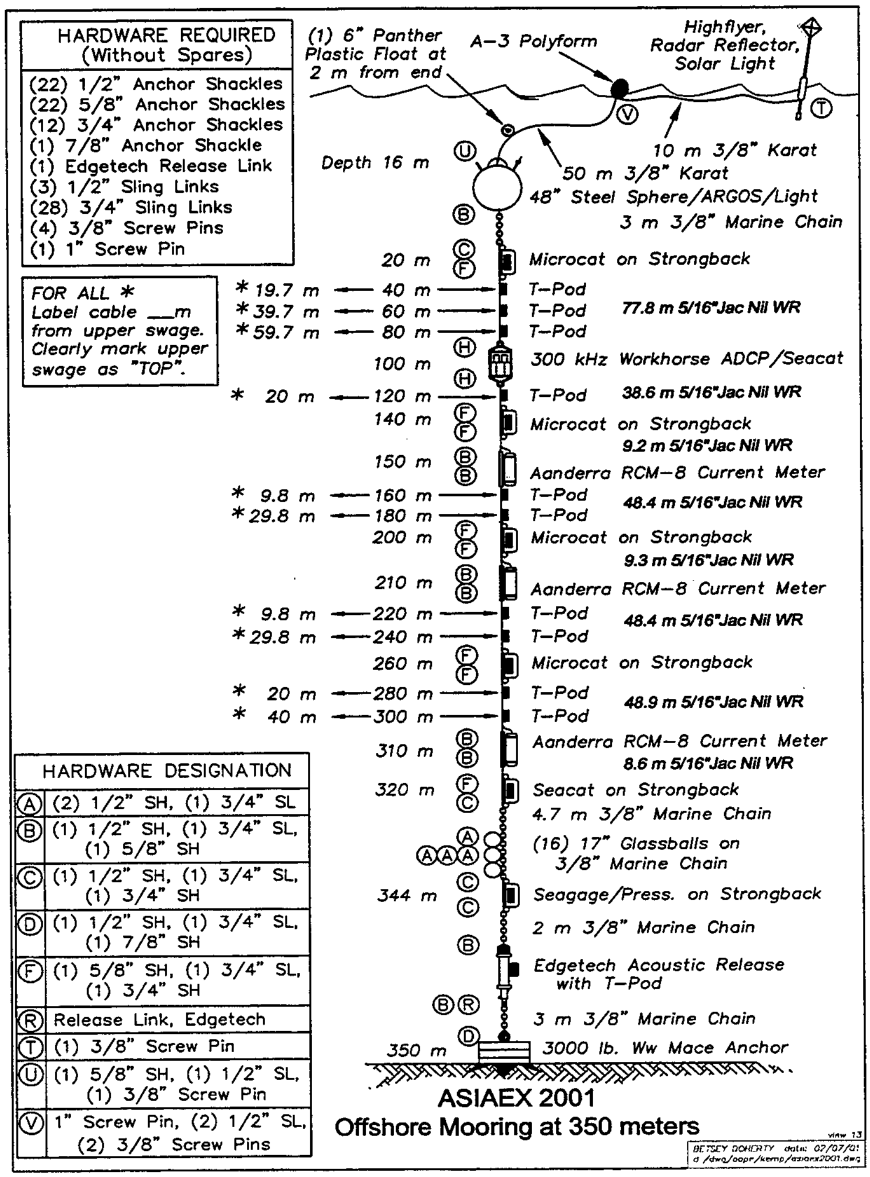

FIGURE 36. Environmental mooring at 350 meters configuration (mooring 13).

8.0 Acknowledgments

To begin with, we would like to acknowledge the people who made ASIAEX happen financially. Drs. Jeff Simmen and Lou Goodman of ONR were our prime supporters, and without their dedication to and belief in this effort, it never would have materialized. We would also like to thank the WHOI Directorate, particularly Dr. Jim Luyten, for putting an enormous amount of 'up-front money' towards this effort. Their belief in our work and in ONR's was put in terms of a very substantial loan of monies, and we gratefully acknowledge this support.

There also was a substantial international component to ASIAEX, and in this arena, we would like to thank the three main US players, Drs. Steve Ramp and Ching-sang Chiu, both of the Naval Postgraduate School, and Dr. Jeff Simmen of ONR. These three gentlemen put a large amount of travel time and communications time into ASIAEX in order to arrange the permits needed and to coordinate the international efforts. Their efforts are warmly acknowledged.

In terms of sea-going support, we would like to thank the captains and crews of the Taiwanese research vessels Fisheries Researcher 1 (*FR1*) and Oceanography Researcher 1 and 3 (*OR1* and *OR3*). Their skill, enthusiasm and professionalism, along with their first rate ships, contributed immeasurably towards making our efforts successful. We'd also like to thank the captain and crew of the guard boat which stood watch over our acoustic array during the experiment, despite running low on food, water, and smokes. These gentlemen gave us some great practical advice, as well as their sea-going support. Shore-side, the support of our first-rate agent, Mr. Wang, and the ever-present warehouse guard were greatly appreciated. Also, the patience of the staff of the Grand Hai-Lai Hotel must be thanked We were not their best dressed guests, though we may have been the best educated!

The support of our colleagues from both the US and Asia is very warmly acknowledged. ASIAEX succeeded as a group effort, and we hope that this report will be of use to that fine group. This thanks also extends to the many universities that opened their doors to numerous 'foreign visitors', and treated us with great warmth and hospitality.

On the WHOI home front, the secretarial and travel arrangement assistance of Ms. Penny Foster and Ms. Marlene Messina are gratefully acknowledged.

Finally, we'd like to re-dedicate our efforts to the memory of Dr. Warren Denner, ASIAEX's first project coordinator. Warren would have been positively ecstatic about seeing the vast and intriguing data set that was collected, and we can only hope he is looking down at us and grinning ear-to-ear!

9.0 Appendix

9.1 Listing of all SHARK data files.

TABLE 47. SHARK data files from DISK0.

05020421.CSD	05021042.CSD	05021629.CSD	05022125.CSD	05030251.CSD
05020438.CSD	05021058.CSD	05021632.CSD	05022142.CSD	05030253.CSD
05020454.CSD	05021115.CSD	05021648.CSD	05022151.CSD	05030310.CSD
05020511.CSD	05021132.CSD	05021652.CSD	05022208.CSD	05030312.CSD
05020528.CSD	05021149.CSD	05021709.CSD	05022212.CSD	05030321.CSD
05020545.CSD	05021205.CSD	05021722.CSD	05022228.CSD	05030338.CSD
05020601.CSD	05021221.CSD	05021738.CSD	05022232.CSD	05030355.CSD
05020618.CSD	05021238.CSD	05021742.CSD	05022249.CSD	05030411.CSD
05020635.CSD	05021242.CSD	05021751.CSD	05022302.CSD	05030428.CSD
05020652.CSD	05021258.CSD	05021801.CSD	05022319.CSD	05030441.CSD
05020709.CSD	05021315.CSD	05021818.CSD	05022335.CSD	05030458.CSD
05020725.CSD	05021331.CSD	05021821.CSD	05022352.CSD	05030515.CSD
05020742.CSD	05021341.CSD	05021838.CSD	05030002.CSD	05030532.CSD
05020759.CSD	05021358.CSD	05021852.CSD	05030018.CSD	05030548.CSD
05020801.CSD	05021401.CSD	05021908.CSD	05030035.CSD	05030552.CSD
05020818.CSD	05021418.CSD	05021922.CSD	05030041.CSD	05030608.CSD
05020835.CSD	05021435.CSD	05021938.CSD	05030058.CSD	05030611.CSD
05020852.CSD	05021452.CSD	05021955.CSD	05030115.CSD	05030628.CSD
05020901.CSD	05021508.CSD	05022012.CSD	05030132.CSD	05030642.CSD
05020918.CSD	05021512.CSD	05022029.CSD	05030148.CSD	05030658.CSD
05020935.CSD	05021528.CSD	05022032.CSD	05030205.CSD	05030715.CSD
05021008.CSD	05021545.CSD	05022048.CSD	05030222.CSD	
05021022.CSD	05021555.CSD	05022051.CSD	05030232.CSD	
05021038.CSD	05021612.CSD	05022108.CSD	05030242.CSD	

TABLE 48. SHARK data files from DISK1.

05030716.CSD	05031332.CSD	05031919.CSD	05040219.CSD	05040749.CSD
05030733.CSD	05031349.CSD	05031935.CSD	05040222.CSD	05040805.CSD
05030750.CSD	05031402.CSD	05031952.CSD	05040239.CSD	05040822.CSD
05030807.CSD	05031412.CSD	05032009.CSD	05040256.CSD	05040832.CSD

TABLE 48. SHARK data files from DISK1.

05030812.CSD	05031428.CSD	05032012.CSD	05040312.CSD	05040849.CSD
05030822.CSD	05031445.CSD	05032029.CSD	05040329.CSD	05040906.CSD
05030832.CSD	05031452.CSD	05032042.CSD	05040342.CSD	05040912.CSD
05030842.CSD	05031509.CSD	05032059.CSD	05040359.CSD	05040929.CSD
05030859.CSD	05031526.CSD	05032112.CSD	05040416.CSD	05040946.CSD
05030916.CSD	05031543.CSD	05032129.CSD	05040422.CSD	05040952.CSD
05030933.CSD	05031559.CSD	05032222.CSD	05040439.CSD	05041002.CSD
05030949.CSD	05031612.CSD	05032232.CSD	05040456.CSD	05041019.CSD
05031006.CSD	05031622.CSD	05032249.CSD	05040502.CSD	05041032.CSD
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05031245.CSD	05031822.CSD	05040123.CSD	05040709.CSD	05041249.CSD
05031302.CSD	05031839.CSD	05040142.CSD	05040712.CSD	
05031312.CSD	05031855.CSD	05040159.CSD	05040729.CSD	
05031329.CSD	05031902.CSD	05040202.CSD	05040732.CSD	

TABLE 49. SHARK data files from DISK2.

05041303.CSD	05041950.CSD	05050212.CSD	05050746.CSD	05051349.CSD
05041312.CSD	05042002.CSD	05050229.CSD	05050752.CSD	05051402.CSD
05041329.CSD	05042012.CSD	05050242.CSD	05050809.CSD	05051419.CSD
05041345.CSD	05042022.CSD	05050242_new. CSD	05050825.CSD	05051422.CSD
05041402.CSD	05042032.CSD	05050252.CSD	05050843.CSD	05051439.CSD
05041412.CSD	05042049.CSD	05050309.CSD	05050852.CSD	05051452.CSD
05041429.CSD	05042106.CSD	05050322.CSD	05050909.CSD	05051509.CSD
05041446.CSD	05042112.CSD	05050339.CSD	05050926.CSD	05051512.CSD
05041452.CSD	05042129.CSD	05050352.CSD	05050943.CSD	05051529.CSD
05041502.CSD	05042146.CSD	05050409.CSD	05050959.CSD	05051546.CSD
05041519.CSD	05042203.CSD	05050412.CSD	05051002.CSD	05051602.CSD
05041536.CSD	05042220.CSD	05050422.CSD	05051012.CSD	05051619.CSD
05041552.CSD	05042236.CSD	05050432.CSD	05051029.CSD	05051635.CSD

TABLE 49. SHARK data files from DISK2.

05041602.CSD	05042253.CSD	05050448.CSD	05051033.CSD	05051652.CSD
05041619.CSD	05042310.CSD	05050452.CSD	05051050.CSD	05051702.CSD
05041632.CSD	05042322.CSD	05050509.CSD	05051107.CSD	05051718.CSD
05041642.CSD	05042339.CSD	05050513.CSD	05051112.CSD	05051722.CSD
05041659.CSD	05042355.CSD	05050530.CSD	05051122.CSD	05051739.CSD
05041716.CSD	05050012.CSD	05050532.CSD	05051139.CSD	05051756.CSD
05041733.CSD	05050029.CSD	05050542.CSD	05051156.CSD	05051806.CSD
05041742.CSD	05050042.CSD	05050559.CSD	05051202.CSD	05051823.CSD
05041752.CSD	05050059.CSD	05050616.CSD	05051219.CSD	05051840.CSD
05041809.CSD	05050102.CSD	05050632.CSD	05051236.CSD	05051857.CSD
05041826.CSD	05050112.CSD	05050649.CSD	05051253.CSD	05051914.CSD
05041842.CSD	05050129.CSD	05050652.CSD	05051309.CSD	
05041859.CSD	05050132.CSD	05050709.CSD	05051312.CSD	
05041916.CSD	05050149.CSD	05050712.CSD	05051329.CSD	
05041933.CSD	05050206.CSD	05050729.CSD	05051332.CSD	

TABLE 50. SHARK data files from DISK3.

05051918.CSD	05060143.CSD	05060806.CSD	05061402.CSD	05061943.CSD
05051922.CSD	05060200.CSD	05060822.CSD	05061419.CSD	05062000.CSD
05051939.CSD	05060212.CSD	05060832.CSD	05061422.CSD	05062016.CSD
05051952.CSD	05060229.CSD	05060849.CSD	05061439.CSD	05062033.CSD
05052002.CSD	05060232.CSD	05060849_new. csd	05061442.CSD	05062042.CSD
05052019.CSD	05060242.CSD	05060906.CSD	05061459.CSD	05062052.CSD
05052036.CSD	05060259.CSD	05060922.CSD	05061512.CSD	05062108.CSD
05052052.CSD	05060316.CSD	05060922_new. csd	05061529.CSD	05062125.CSD
05052109.CSD	05060332.CSD	05060939.CSD	05061533.CSD	05062142.CSD
05052122.CSD	05060349.CSD	05060956.CSD	05061542.CSD	05062159.CSD
05052139.CSD	05060402.CSD	05061013.CSD	05061559.CSD	05062216.CSD
05052156.CSD	05060419.CSD	05061030.CSD	05061612.CSD	05062232.CSD
05052212.CSD	05060436.CSD	05061032.CSD	05061629.CSD	05062249.CSD
05052229.CSD	05060442.CSD	05061042.CSD	05061632.CSD	05062306.CSD
05052242.CSD	05060458.CSD	05061052.CSD	05061649.CSD	05062312.CSD
05052259.CSD	05060512.CSD	05061109.CSD	05061652.CSD	05062329.CSD
05052315.CSD	05060522.CSD	05061112.CSD	05061702.CSD	05062345.CSD
05052332.CSD	05060538.CSD	05061129.CSD	05061719.CSD	05070002.CSD
05052349.CSD	05060555.CSD	05061142.CSD	05061722.CSD	05070019.CSD
05052352.CSD	05060612.CSD	05061159.CSD	05061739.CSD	05070036.CSD
05060009.CSD	05060622.CSD	05061216.CSD	05061755.CSD	05070053.CSD

TABLE 50. SHARK data files from DISK3.

05060026.CSD	05060639.CSD	05061232.CSD	05061802.CSD	05070109.CSD
05060032.CSD	05060655.CSD	05061249.CSD	05061819.CSD	05070112.CSD
05060048.CSD	05060712.CSD	05061302.CSD	05061835.CSD	
05060052.CSD	05060729.CSD	05061319.CSD	05061852.CSD	
05060109.CSD	05060732.CSD	05061336.CSD	05061909.CSD	
05060126.CSD	05060749.CSD	05061352.CSD	05061926.CSD	

TABLE 51. SHARK data files from DISK4.

05070113.CSD	05070722.CSD	05071322.CSD	05071959.CSD	05080219.CSD
05070129.CSD	05070732.CSD	05071332.CSD	05072012.CSD	05080232.CSD
05070142.CSD	05070742.CSD	05071349.CSD	05072029.CSD	05080249.CSD
05070152.CSD	05070759.CSD	05071405.CSD	05072046.CSD	05080252.CSD
05070209.CSD	05070816.CSD	05071422.CSD	05072103.CSD	05080302.CSD
05070222.CSD	05070833.CSD	05071438.CSD	05072120.CSD	05080312.CSD
05070239.CSD	05070850.CSD	05071442.CSD	05072132.CSD	05080329.CSD
05070256.CSD	05070906.CSD	05071452.CSD	05072142.CSD	05080332.CSD
05070302.CSD	05070913.CSD	05071509.CSD	05072152.CSD	05080342.CSD
05070312.CSD	05070930.CSD	05071526.CSD	05072209.CSD	05080352.CSD
05070329.CSD	05070947.CSD	05071542.CSD	05072212.CSD	05080402.CSD
05070346.CSD	05071002.CSD	05071559.CSD	05072229.CSD	05080419.CSD
05070402.CSD	05071019.CSD	05071612.CSD	05072232.CSD	05080432.CSD
05070412.CSD	05071022.CSD	05071629.CSD	05072249.CSD	05080448.CSD
05070429.CSD	05071039.CSD	05071645.CSD	05072302.CSD	05080505.CSD
05070446.CSD	05071042.CSD	05071702.CSD	05072319.CSD	05080522.CSD
05070452.CSD	05071059.CSD	05071712.CSD	05072332.CSD	05080539.CSD
05070509.CSD	05071112.CSD	05071722.CSD	05072342.CSD	05080552.CSD
05070512.CSD	05071129.CSD	05071739.CSD	05072359.CSD	05080602.CSD
05070529.CSD	05071142.CSD	05071752.CSD	05080012.CSD	05080619.CSD
05070543.CSD	05071152.CSD	05071809.CSD	05080029.CSD	05080632.CSD
05070552.CSD	05071208.CSD	05071822.CSD	05080032.CSD	05080649.CSD
05070602.CSD	05071212.CSD	05071838.CSD	05080049.CSD	05080706.CSD
05070619.CSD	05071229.CSD	05071842.CSD	05080102.CSD	05080722.CSD
05070623.CSD	05071232.CSD	05071852.CSD	05080112.CSD	05080739.CSD
05070632.CSD	05071249.CSD	05071908.CSD	05080129.CSD	05080742.CSD
05070649.CSD	05071302.CSD	05071925.CSD	05080145.CSD	05080752.CSD
05070706.CSD	05071319.CSD	05071942.CSD	05080202.CSD	

TABLE 52. SHARK data files from DISK5.

05080755.CSD	05081419.CSD	05082052.CSD	05090302.CSD	05090919.CSD
05080812.CSD	05081432.CSD	05082109.CSD	05090318.CSD	05090936.CSD
05080822.CSD	05081449.CSD	05082122.CSD	05090332.CSD	05090953.CSD
05080839.CSD	05081503.CSD	05082132.CSD	05090342.CSD	05091002.CSD
05080855.CSD	05081512.CSD	05082149.CSD	05090359.CSD	05091012.CSD
05080902.CSD	05081529.CSD	05082152.CSD	05090402.CSD	05091029.CSD
05080919.CSD	05081542.CSD	05082209.CSD	05090412.CSD	05091045.CSD
05080932.CSD	05081559.CSD	05082222.CSD	05090429.CSD	05091052.CSD
05080942.CSD	05081612.CSD	05082238.CSD	05090432.CSD	05091102.CSD
05080959.CSD	05081629.CSD	05082255.CSD	05090448.CSD	05091119.CSD
05081016.CSD	05081642.CSD	05082302.CSD	05090452.CSD	05091135.CSD
05081022.CSD	05081658.CSD	05082312.CSD	05090509.CSD	05091142.CSD
05081032.CSD	05081702.CSD	05082329.CSD	05090526.CSD	05091159.CSD
05081049.CSD	05081719.CSD	05082332.CSD	05090542.CSD	05091216.CSD
05081052.CSD	05081736.CSD	05082349.CSD	05090553.CSD	05091233.CSD
05081109.CSD	05081752.CSD	05090006.CSD	05090610.CSD	05091242.CSD
05081112.CSD	05081808.CSD	05090012.CSD	05090627.CSD	05091259.CSD
05081129.CSD	05081812.CSD	05090029.CSD	05090642.CSD	05091302.CSD
05081146.CSD	05081822.CSD	05090046.CSD	05090659.CSD	05091312.CSD
05081202.CSD	05081832.CSD	05090103.CSD	05090716.CSD	05091329.CSD
05081212.CSD	05081842.CSD	05090119.CSD	05090732.CSD	05091342.CSD
05081228.CSD	05081858.CSD	05090136.CSD	05090742.CSD	05091359.CSD
05081242.CSD	05081915.CSD	05090153.CSD	05090752.CSD	05091415.CSD
05081258.CSD	05081932.CSD	05090210.CSD	05090809.CSD	
05081312.CSD	05081949.CSD	05090222.CSD	05090822.CSD	
05081329.CSD	05082005.CSD	05090239.CSD	05090839.CSD	
05081346.CSD	05082022.CSD	05090242.CSD	05090856.CSD	
05081402.CSD	05082039.CSD	05090258.CSD	05090902.CSD	

TABLE 53. SHARK data files from DISK6.

05091423.CSD	05091952.CSD	05100142.CSD	05100810.CSD	05101425.CSD
05091432.CSD	05092009.CSD	05100158.CSD	05100826.CSD	05101442.CSD
05091449.CSD	05092022.CSD	05100215.CSD	05100843.CSD	05101459.CSD
05091505.CSD	05092032.CSD	05100222.CSD	05100900.CSD	05101516.CSD
05091522.CSD	05092049.CSD	05100239.CSD	05100917.CSD	05101533.CSD
05091539.CSD	05092052.CSD	05100252.CSD	05100933.CSD	05101549.CSD
05091542.CSD	05092109.CSD	05100302.CSD	05100950.CSD	05101606.CSD
05091552.CSD	05092122.CSD	05100318.CSD	05100952.CSD	05101622.CSD

TABLE 53. SHARK data files from DISK6.

05091609.CSD	05092138.CSD	05100335.CSD	05101009.CSD	05101639.CSD
05091622.CSD	05092142.CSD	05100342.CSD	05101026.CSD	05101652.CSD
05091639.CSD	05092159.CSD	05100358.CSD	05101032.CSD	05101702.CSD
05091656.CSD	05092215.CSD	05100402.CSD	05101042.CSD	05101718.CSD
05091713.CSD	05092232.CSD	05100419.CSD	05101059.CSD	05101735.CSD
05091722.CSD	05092249.CSD	05100436.CSD	05101116.CSD	05101752.CSD
05091738.CSD	05092302.CSD	05100452.CSD	05101132.CSD	05101809.CSD
05091742.CSD	05092319.CSD	05100509.CSD	05101142.CSD	05101812.CSD
05091759.CSD	05092322.CSD	05100522.CSD	05101159.CSD	05101822.CSD
05091802.CSD	05092338.CSD	05100539.CSD	05101216.CSD	05101832.CSD
05091812.CSD	05092352.CSD	05100555.CSD	05101233.CSD	05101848.CSD
05091829.CSD	05100002.CSD	05100612.CSD	05101249.CSD	05101905.CSD
05091845.CSD	05100019.CSD	05100629.CSD	05101306.CSD	05101912.CSD
05091852.CSD	05100035.CSD	05100646.CSD	05101323.CSD	05101929.CSD
05091909.CSD	05100052.CSD	05100702.CSD	05101332.CSD	05101932.CSD
05091912.CSD	05100109.CSD	05100719.CSD	05101349.CSD	05101949.CSD
05091922.CSD	05100126.CSD	05100736.CSD	05101352.CSD	05102006.CSD
05091939.CSD	05100132.CSD	05100753.CSD	05101408.CSD	

TABLE 54. SHARK data files from DISK7.

05102011.CSD	05110213.CSD	05110812.CSD	05111419.CSD	05112046.CSD
05102027.CSD	05110229.CSD	05110829.CSD	05111422.CSD	05112102.CSD
05102043.CSD	05110246.CSD	05110846.CSD	05111439.CSD	05112119.CSD
05102100.CSD	05110303.CSD	05110903.CSD	05111456.CSD	05112136.CSD
05102112.CSD	05110320.CSD	05110920.CSD	05111513.CSD	05112142.CSD
05102129.CSD	05110322.CSD	05110936.CSD	05111529.CSD	05112159.CSD
05102146.CSD	05110339.CSD	05110953.CSD	05111542.CSD	05112212.CSD
05102202.CSD	05110356.CSD	05111010.CSD	05111552.CSD	05112228.CSD
05102212.CSD	05110412.CSD	05111027.CSD	05111609.CSD	05112242.CSD
05102222.CSD	05110429.CSD	05111032.CSD	05111626.CSD	05112259.CSD
05102239.CSD	05110446.CSD	05111049.CSD	05111642.CSD	05112312.CSD
05102242.CSD	05110452.CSD	05111106.CSD	05111659.CSD	05112329.CSD
05102252.CSD	05110509.CSD	05111123.CSD	05111716.CSD	05112332.CSD
05102309.CSD	05110526.CSD	05111140.CSD	05111732.CSD	05112342.CSD
05102312.CSD	05110532.CSD	05111152.CSD	05111742.CSD	05112358.CSD
05102329.CSD	05110548.CSD	05111209.CSD	05111759.CSD	05120015.CSD
05102342.CSD	05110605.CSD	05111222.CSD	05111816.CSD	05120032.CSD
05102359.CSD	05110622.CSD	05111232.CSD	05111832.CSD	05120049.CSD
05110016.CSD	05110632.CSD	05111249.CSD	05111849.CSD	05120106.CSD

TABLE 54. SHARK data files from DISK7.

05110033.CSD	05110649.CSD	05111252.CSD	05111906.CSD	05120112.CSD
05110049.CSD	05110706.CSD	05111309.CSD	05111923.CSD	05120129.CSD
05110106.CSD	05110719.CSD	05111325.CSD	05111940.CSD	
05110122.CSD	05110736.CSD	05111342.CSD	05111956.CSD	
05110139.CSD	05110753.CSD	05111352.CSD	05112012.CSD	
05110156.CSD	05110809.CSD	05111402.CSD	05112029.CSD	

No data from DISK8.

TABLE 55. SHARK data files from DISK9.

05120143.CSD	05120812.CSD	05121346.CSD	05121942.CSD	05130152.CSD
05120143_new.csd	05120829.CSD	05121402.CSD	05121952.CSD	05130209.CSD
05120200.CSD	05120832.CSD	05121419.CSD	05122002.CSD	05130226.CSD
05120216.CSD	05120849.CSD	05121436.CSD	05122018.CSD	05130242.CSD
05120233.CSD	05120852.CSD	05121436.csd	05122035.CSD	05130259.CSD
05120250.CSD	05120909.CSD	05121436_new.csd	05122052.CSD	05130316.CSD
05120307.CSD	05120926.CSD	05121452.CSD	05122109.CSD	05130333.CSD
05120323.CSD	05120932.CSD	05121509.CSD	05122112.CSD	05130342.CSD
05120342.CSD	05120942.CSD	05121526.CSD	05122129.CSD	05130359.CSD
05120353.CSD	05120959.CSD	05121542.CSD	05122146.CSD	05130412.CSD
05120410.CSD	05121016.CSD	05121559.CSD	05122203.CSD	05130429.CSD
05120427.CSD	05121032.CSD	05121615.CSD	05122219.CSD	05130446.CSD
05120443.CSD	05121049.CSD	05121622.CSD	05122236.CSD	05130503.CSD
05120500.CSD	05121106.CSD	05121639.CSD	05122253.CSD	05130512.CSD
05120517.CSD	05121123.CSD	05121656.CSD	05122310.CSD	05130529.CSD
05120534.CSD	05121139.CSD	05121713.CSD	05122326.CSD	05130532.CSD
05120551.CSD	05121142.CSD	05121729.CSD	05122332.CSD	05130542.CSD
05120602.CSD	05121159.CSD	05121746.CSD	05122349.CSD	05130558.CSD
05120618.CSD	05121212.CSD	05121752.CSD	05130005.CSD	05130615.CSD
05120635.CSD	05121229.CSD	05121809.CSD	05130012.CSD	05130632.CSD
05120652.CSD	05121245.CSD	05121822.CSD	05130028.CSD	05130642.CSD
05120709.CSD	05121252.CSD	05121839.CSD	05130045.CSD	05130659.CSD
05120726.CSD	05121309.CSD	05121852.CSD	05130102.CSD	05130702.CSD
05120742.CSD	05121312.CSD	05121909.CSD	05130119.CSD	
05120759.CSD	05121329.CSD	05121925.CSD	05130135.CSD	

TABLE 56. SHARK data files from DISK10.

05130710.CSD	05131422.CSD	05132232.CSD	05140629.CSD
05130726.CSD	05131432.CSD	05132249.CSD	05140642.CSD
05130743.CSD	05131448.CSD	05132306.CSD	05140659.CSD
05130743.csd	05131453.CSD	05132322.CSD	05140702.CSD
05130743_new.csd	05131502.CSD	05132339.CSD	05140719.CSD
05130800.CSD	05131518.CSD	05132356.CSD	05140736.CSD
05130802.CSD	05131535.CSD	05140002.CSD	05140736.csd
05130819.CSD	05131552.CSD	05140019.CSD	05140736_new.csd
05130822.CSD	05131609.CSD	05140036.CSD	05140742.CSD
05130839.CSD	05131612.CSD	05140052.CSD	05140759.CSD
05130856.CSD	05131629.CSD	05140109.CSD	05140816.CSD
05130912.CSD	05131642.CSD	05140126.CSD	05140832.CSD
05130922.CSD	05131659.CSD	05140126.csd	05140849.CSD
05130932.CSD	05131712.CSD	05140126_new.csd	05140852.CSD
05130948.CSD	05131729.CSD	05140143.CSD	05140909.CSD
05130952.CSD	05131746.CSD	05140200.CSD	05140926.CSD
05131009.CSD	05131803.CSD	05140216.CSD	05140940.CSD
05131026.CSD	05131820.CSD	05140233.CSD	05140952.CSD
05131032.CSD	05131836.CSD	05140250.CSD	05141009.CSD
05131049.CSD	05131852.CSD	05140253.CSD	05141025.CSD
05131106.CSD	05131902.CSD	05140310.CSD	05141042.CSD
05131122.CSD	05131919.CSD	05140322.CSD	05141059.CSD
05131139.CSD	05131936.CSD	05140332.CSD	05141116.CSD
05131152.CSD	05131953.CSD	05140342.CSD	05141122.CSD
05131209.CSD	05132010.CSD	05140358.CSD	05141132.CSD
05131222.CSD	05132026.CSD	05140415.CSD	05141142.CSD
05131239.CSD	05132043.CSD	05140432.CSD	05141152.CSD
05131252.CSD	05132052.CSD	05140449.CSD	05141209.CSD
05131309.CSD	05132109.CSD	05140506.CSD	05141226.CSD
05131322.CSD	05132112.CSD	05140512.CSD	05141243.CSD
05131339.CSD	05132129.CSD	05140528.CSD	05141259.CSD
05131342.CSD	05132145.CSD	05140545.CSD	05141302.CSD
05131359.CSD	05132202.CSD	05140602.CSD	
05131412.CSD	05132219.CSD	05140612.CSD	

TABLE 57. SHARK data files from DISK11.

05141303.CSD	05141922.CSD	05150232.CSD	05150849.CSD	05151435.CSD
05141312.CSD	05141939.CSD	05150249.CSD	05150905.CSD	05151442.CSD

TABLE 57. SHARK data files from DISK11.

05141322.CSD	05141956.CSD	05150306.CSD	05150922.CSD	05151459.CSD
05141339.CSD	05142013.CSD	05150312.CSD	05150932.CSD	05151516.CSD
05141352.CSD	05142029.CSD	05150329.CSD	05150949.CSD	05151533.CSD
05141402.CSD	05142046.CSD	05150342.CSD	05151005.CSD	05151542.CSD
05141419.CSD	05142103.CSD	05150359.CSD	05151012.CSD	05151558.CSD
05141422.CSD	05142120.CSD	05150416.CSD	05151029.CSD	05151602.CSD
05141439.CSD	05142137.CSD	05150432.CSD	05151032.CSD	05151619.CSD
05141453.CSD	05142142.CSD	05150449.CSD	05151048.CSD	05151635.CSD
05141502.CSD	05142158.CSD	05150506.CSD	05151105.CSD	05151652.CSD
05141518.CSD	05142215.CSD	05150522.CSD	05151122.CSD	05151709.CSD
05141535.CSD	05142232.CSD	05150532.CSD	05151132.CSD	05151722.CSD
05141552.CSD	05142249.CSD	05150548.CSD	05151149.CSD	05151732.CSD
05141609.CSD	05142306.CSD	05150605.CSD	05151152.CSD	05151742.CSD
05141626.CSD	05142322.CSD	05150622.CSD	05151209.CSD	05151759.CSD
05141642.CSD	05142339.CSD	05150639.CSD	05151212.CSD	05151815.CSD
05141659.CSD	05142356.CSD	05150652.CSD	05151229.CSD	05151823.CSD
05141716.CSD	05150012.CSD	05150702.CSD	05151233.CSD	05151832.CSD
05141733.CSD	05150023.CSD	05150712.CSD	05151249.CSD	05151842.CSD
05141742.CSD	05150040.CSD	05150729.CSD	05151302.CSD	05151859.CSD
05141752.CSD	05150052.CSD	05150732.CSD	05151319.CSD	
05141809.CSD	05150109.CSD	05150749.CSD	05151336.CSD	
05141826.CSD	05150126.CSD	05150803.CSD	05151342.CSD	
05141843.CSD	05150142.CSD	05150812.CSD	05151352.CSD	
05141852.CSD	05150158.CSD	05150829.CSD	05151402.CSD	
05141909.CSD	05150215.CSD	05150832.CSD	05151418.CSD	

No data from DISK12.

TABLE 58. SHARK data files from DISK13.

05151925.CSD	05160049.CSD	05160622.CSD	05161142.CSD	05161759.CSD
05151942.CSD	05160106.CSD	05160632.CSD	05161159.CSD	05161802.CSD
05151958.CSD	05160122.CSD	05160642.CSD	05161216.CSD	05161819.CSD
05152012.CSD	05160139.CSD	05160659.CSD	05161232.CSD	05161836.CSD
05152029.CSD	05160142.CSD	05160702.CSD	05161249.CSD	05161852.CSD
05152045.CSD	05160152.CSD	05160719.CSD	05161252.CSD	05161909.CSD
05152052.CSD	05160209.CSD	05160722.CSD	05161308.CSD	05161926.CSD
05152109.CSD	05160226.CSD	05160739.CSD	05161325.CSD	05161942.CSD
05152113.CSD	05160243.CSD	05160753.CSD	05161342.CSD	05161959.CSD

TABLE 58. SHARK data files from DISK13.

05152132.CSD	05160300.CSD	05160802.CSD	05161359.CSD	05162016.CSD
05152149.CSD	05160316.CSD	05160819.CSD	05161416.CSD	05162033.CSD
05152152.CSD	05160333.CSD	05160822.CSD	05161432.CSD	05162050.CSD
05152209.CSD	05160350.CSD	05160839.CSD	05161449.CSD	05162106.CSD
05152226.CSD	05160407.CSD	05160856.CSD	05161506.CSD	05162123.CSD
05152232.CSD	05160407_new. CSD	05160913.CSD	05161523.CSD	05162132.CSD
05152242.CSD	05160423.CSD	05160930.CSD	05161540.CSD	05162149.CSD
05152252.CSD	05160433.CSD	05160932.CSD	05161542.CSD	05162152.CSD
05152309.CSD	05160450.CSD	05160949.CSD	05161552.CSD	05162209.CSD
05152322.CSD	05160452.CSD	05161006.CSD	05161609.CSD	05162222.CSD
05152339.CSD	05160509.CSD	05161006_new. CSD	05161626.CSD	05162239.CSD
05152352.CSD	05160512.CSD	05161022.CSD	05161643.CSD	05162256.CSD
05160002.CSD	05160528.CSD	05161039.CSD	05161659.CSD	05162312.CSD
05160012.CSD	05160532.CSD	05161056.CSD	05161712.CSD	05162329.CSD
05160028.CSD	05160549.CSD	05161113.CSD	05161729.CSD	05162346.CSD
05160032.CSD	05160606.CSD	05161130.CSD	05161742.CSD	

TABLE 59. SHARK data files from DISK14.

05162355.csd	05170029.csd	05170100.csd	05170119.csd
05170012.csd	05170043.csd	05170102.csd	05170132.csd

TABLE 60. SHARK data files from DISK15.

5170102.ps	05170145.csd	05170202.csd	05170212.csd

TABLE 61. SHARK data files from DISK16.

05170225.csd	

TABLE 62. SHARK data files from DISK17.

05170235.csd	05170322.csd	05170422.csd	05170516.csd
05170242.csd	05170332.csd	05170439.csd	05170532.csd
05170252.csd	05170349.csd	05170442.csd	05170549.csd
05170309.csd	05170405.csd	05170459.csd	

TABLE 63. SHARK data files from DISK18.

05170555.csd	05170602.csd	05170619.csd	5170636.csd

TABLE 64. SHARK data files from DISK19.

05170645.csd	05170709.csd	05170743.csd	
05170652.csd	05170726.csd	05170759.csd	

TABLE 65. SHARK data files from DISK20.

05170815.csd	05170942.csd	05171122.csd	05171303.csd	05171453.csd
05170832.csd	05170952.csd	05171139.csd	05171320.csd	05171510.csd
05170843.csd	05171009.csd	05171153.csd	05171332.csd	
05170900.csd	05171026.csd	05171210.csd	05171349.csd	
05170916.csd	05171042.csd	05171222.csd	05171402.csd	
05170922.csd	05171059.csd	05171239.csd	05171419.csd	
05170939.csd	05171116.csd	05171252.csd	05171436.csd	

No data from disk21.

TABLE 66. SHARK data files from DISK22.

05171515.csd	05171553.csd	05171644.csd	05171722.csd
05171532.csd	05171610.csd	05171702.csd	05171732.csd
05171548.csd	05171627.csd	05171719.csd	05171749.csd

TABLE 67. SHARK data files from DISK23.

05171805.csd	05172012.csd	05172246.csd	05180126.csd	05180346.csd
05171822.csd	05172029.csd	05172303.csd	05180143.csd	05180402.csd
05171832.csd	05172033.csd	05172320.csd	05180159.csd	05180419.csd
05171843.csd	05172050.csd	05172336.csd	05180202.csd	05180436.csd
05171900.csd	05172107.csd	05172353.csd	05180212.csd	05180442.csd
05171916.csd	05172122.csd	05180010.csd	05180228.csd	05180459.csd
05171922.csd	05172139.csd	05180022.csd	05180245.csd	
05171939.csd	05172156.csd	05180039.csd	05180302.csd	
05171942.csd	05172212.csd	05180052.csd	05180312.csd	
05171959.csd	05172229.csd	05180109.csd	05180329.csd	

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16. Abstract (Limit: 200 words)
The Asian Seas International Experiment (ASIAEX) was a very successful scientific collaboration between the United States of America (USA), the People's Republic of China (PRC), Taiwan (ROC), the Republic of Korea (ROK), Japan, Russia, and Singapore. Preliminary field experiments associated with ASIAEX began in spring of 2000. The main experiments were performed in April-August, 2001. The scientific plan called for two major acoustics experiments, the first a bottom interaction experiment in the East China Sea (ECS) and the second a volume interaction experiment in the South China Sea (SCS). In addition to the acoustics efforts, there were also extremely strong physical oceanography and geology and geophysics components to the experiments. This report will concentrate on describing the moored component of the South China Sea portion of ASIAEX 2001 performed from the Taiwan Fisheries research vessel FR1 (Fisheries Researcher 1). Information on the environmental moorings deployed from the Taiwanese oceanographic research vessel OR1 (Oceanographic Researcher 1) will also be listed here for completeness, so that the reader can pursue later analyses of the data. This report does not pursue any data analyses per se.

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