

L-CHEAPO 2000 OPERATIONS ON EW0113

R/V Maurice Ewing
October 27 – December 2, 2002

BACKGROUND

This project was originally slated to survey the Gulf of Aden aboard the R/V Maurice Ewing beginning on September 15, 2002 and sailing out of Djibouti, Africa. However, due to an unfortunate combination of events including an attack of the Ewing by pirates a few weeks prior to departure and the events of September 11th the original cruise had to be cancelled. As an alternative science plan it was decided by the principle investigators (with the backing of NSF) to attempt a seismic reflection/refraction project off the Exmouth plateau in Northwest Australia. As a result, this experiment turned out to be one of the most complicated and trying cruises for the Scripps Ocean Bottom Seismograph Instrumentation Pool (OBSIP) facility.

The decision to change experiment sites posed many logistical difficulties for the OBS team. The original Gulf of Aden experiment called for 20 OBS instruments to be deployed twice. In June of 2002 Scripps had also been involved in a project involving 24 OBS instruments off Bermuda – these same 24 instruments would also be used for the Gulf of Aden cruise. Sailing from San Juan, Puerto Rico May 31 and arriving in St. George, Bermuda on June 29, there was not sufficient time to return the set of instruments back to San Diego after the Bermuda cruise and subsequently ship instruments to Djibouti. Thus, instruments were directly shipped to Djibouti from St. George, Bermuda. With the cancellation of the Aden project, the fleet of 24 LC2000 instruments was then stranded in Djibouti. Arrangements were made to ship the instruments directly to Fremantle, Australia to field the Exmouth project leaving October 27. This was no small task, as the timeline to ship between Djibouti and Fremantle would be very tight in order to meet the proposed sail date. Upon arrival by the science crew in Perth, it was determined that the container would not physically arrive in Fremantle via cargo ship until Monday the 29th, two days after the proposed sail date. A decision was made by the Chief Scientist to delay the sail date until the shipment arrived. Thanks in great part to the efforts of Mike Rossin from Lamont we were able to arrange all pertinent paperwork and customs inspections electronically to expedite container clearance. The 20' shipping container arrived Monday the 29th at ~7pm on the dock next to the Ewing and the ship sailed at ~2am on the morning of the 29th. Upon return to Fremantle after the conclusion of operations the instruments were shipped back to San Diego via Sydney, Australia, which completed an entire circuit around the globe.

PERSONNEL

The OBSIP checkout and deployment team for this trip consisted of two experienced lab personnel. Additional help was obtained from ship's crewmembers, scientists and students to operate the controls for the winch and A-frame and handle lines during the deployments and recoveries. Twelve-hour shifts were run with at least one OBSIP personnel on duty at any given time. A team of 3-4 scientists was on call for each shift assisting in instrument preparation. This cruise would have normally required 3 OBSIP personnel, however, due to the unfortunate circumstances occurring prior to the cruise a member of the OBS lab that was originally slated to participate quit his job only a week prior to departure. Though the OBS team was a bit shorthanded, the participation of the science party in OBS checkouts and deployments facilitated a successful cruise.

LAB AND DECK SETUP

The lab equipment and most of the units in the system of racks for storing instrument frames and float assemblies was unloaded from the container on 'B' deck, and transferred to the fantail on 'D' deck using the ship's cranes while still in port. Much to our surprise, as the 20' container was picked off the dock prior to moving onto the Ewing the hydraulic break of the crane failed and the entire container dropped ~6 ft. onto the dock. Fortunately no injuries to people or damage to instrumentation occurred. Several crewmembers assisted in rigging and operating the cranes and moving the racks around on deck. This operation consumed three hours after the container was secured on deck.

A stand for instrument assembly and for holding instruments on recovery was located under the A-frame on the waist deck on the starboard side. Four stacked pairs of instrument frame racks were strapped in place just aft of the A-frame with about a foot between the racks and the rail. Float racks were located in the available space aft on the fantail. Two stacks of anchors were also tied down on the fantail.

Lab equipment was stored in Zarges boxes, which were brought down to the fantail and stored in the dry lab on the port side. All the boxes were lowered using the ship's crane in two lifts using cargo nets. Five data logger pressure case stands, two laptop computers and other pieces of test equipment were set up on the workbench along the outboard side of the Ewing's dry lab.

ACOUSTICS

An AC-powered acoustic transceiver was used to range to the instruments and generate commands for all communication with the instruments in the water. A battery-powered acoustic unit was employed for testing the instrument transponders on deck prior to deployment. The acoustic transceiver in the lab was connected to the ship's 12 kHz hull transducer. This arrangement yielded outstanding performance; the only missed ranges usually occurred when the instrument was on or near the surface, where intermittent contact is to be expected.

Before deployment, a frame containing 12 of the acoustic transponders used in the instruments was lowered on a wire to a depth that was a few hundred meters above the seafloor to test the watertight integrity and operational performance of each unit. Two deployments were required, all of the transponders worked properly except for acoustic unit #29. Upon inspection in the lab after deployments it was discovered that unit #29 had a loose connector, probably occurring during the transit to Fremantle. The connector was re-seated and the unit was cleared for deployment.

CHECKOUT, ASSEMBLY AND DEPLOYMENT

To prepare each instrument for deployment, the data logger pressure case was removed from the instrument frame while the frame was still stored in the rack. Two people then carried each anchor, instrument frame and float frame to the assembly stand under the A-frame. While one member of the OBS team assembled the release system and checked out the acoustic transponder on deck, another tested and prepared the data logger within the lab for deployment. Members of the science party provided assistance for all operations.

The data logger checklist consists of a single page that includes current and voltage tests, a short suite of electronics tests, and the setting of experiment parameters using a terminal. The instruments were set to record hydrophone and seismometer data at 125 samples per second. Though the instrument is designed so that it should not be necessary to open after shipment from the Scripps OBS lab, all the pressure cases were opened in order change lithium batteries following their direct transit from

Bermuda. Both the mechanical assembly on deck and the data logger checkout in the lab were usually completed within 30 minutes.

Deployment was uneventful. A "tugger" winch was used to deploy the instruments from the starboard A-frame, with a "pelican hook" to release the instrument from the winch wire once it was in the water. Again, calm sea conditions made this a very simple operation.

During the first deployment the first few instruments were followed to the bottom using the acoustic ranging system, then their acoustic transponders were disabled once they were on the bottom. The instruments consistently followed a descent rate of ~50 meters per minute. Once the reliability of the acoustics system had been established, the transponders on the remaining instruments were disabled after they had descended to about 500 meters to allow the ship to proceed without delay to the next deployment site.

RECOVERY PROCEDURES

Nearly all the releases required approximately seven minutes of burn time before the instrument lifted off from its anchor. The instruments rose to the surface at a rise rate of 50 meters per minute, roughly the same as the descent rate during deployment. GPS navigation allowed positioning of the ship so that the instruments were easily sighted when they broke the surface, at ranges of between 50 and 500 yards. Spotting the flashing light at night proved easier than seeing the flag in daylight. It typically took 10-15 minutes for the ship to maneuver and pick up an instrument after reaching the surface. Once aboard, data logger status and clock were checked, the remaining data in the buffer transferred to the disk. Mechanical hardware was disassembled and stored in the racks.

During the second deployment a procedure was enacted for deep-water recoveries in which the Ewing's fast rescue boat was used to precede the Ewing by one to two stations. Using a portable acoustics deck box and a dunking transducer to release instruments from the bottom early, this circumvented the 2-hours normally spent on station waiting for instrument to rise through the water column. Radio contact was continually maintained on the fast rescue boat so that each unit could be released from the bottom enough time in advance to have them reach the surface as the Ewing reached station. This procedure can only be accomplished during daylight hours and with optimal sea conditions. An estimated 8 hours of ship time was saved during one day of recovery procedures using this method.

OVERVIEW OF DEPLOYMENT 1

During the previous Bermuda cruise one data logger was used to provide a spare A-to-D board and Seascan time base for other units and, therefore, was not available. During electronics checkout in the lab one unit repeatedly failed to spin up the disk drive. After opening the unit it was discovered that the digital battery pack was low. It was replaced and then deemed fit for deployment. Four units prepared for deployment had never been tested at sea and were strategically located in positions less critical in the event of failure. Instrument deployment began at 09:42 on Friday, Nov. 2 and was completed at 06:39 on Saturday, Nov. 3. A total of 23 instruments were deployed on line 1, table 1 gives an overview of deployment information.

Instrument recoveries began at 14:00 on Tuesday, Nov. 6 and were done in the same order as deployment. The first 7 recoveries were accomplished without any difficulties. However, instrument Euro (s/n 16 – site 8) would not respond to the ship acoustics. Despite 3-hours of efforts to establish communication using various techniques we could not get a response from the unit. At 7:15 on Nov. 6 the instrument was declared lost. After a lengthy deliberation it was determined that the most likely scenario is that the instrument released prematurely and was probably adrift at the sea surface. As a

secondary design modification to raise the instrument out of the mud, instruments during this deployment were fitted with an 8" riser between the main instrument frame and the grate anchor. A wire rope assembly was used to fasten the mechanical release to the anchor. Several tests on the deck of the Ewing showed that the wire rope was susceptible to stretch and even break given enough force. The preferred theory for early release is that the instrument may have "kited" during descent, or possibly descended at an angle, and, upon reaching the seafloor, torqued the wire rope assembly enough for failure and premature release. Instruments at sites 9 through 22 were then recovered without incident; however, instrument Wombat (s/n 15 – site 23) encountered the same fate as Euro. At 4:15 on Nov. 9th Wombat was declared lost and the recovery operations were complete.

Upon recovery clock drift with respect to GPS time was immediately determined. Clock drift is highly dependent upon temperature, in a relatively constant temperature environment (as can be expected on the seafloor) the clock drift is assumed to be linear. Data from instruments was then dumped to disk and a duplicate copy of the raw data was burned to an optical CD. Instrument Platypus (s/n 10 – site 15) did not properly enter the data acquisition sequence and, thus, recorded no data. This instrument was known to have intermittent problems before the experiment but was deployed as a supplement. This unit was shelved and not used during the second deployment. A summary of clock drifts and data recorded is shown in Table 2.

OVERVIEW OF DEPLOYMENT 2

Instrument deployments for line 2 began at 12:08 on Thursday, Nov. 22 (Thanksgiving!). OBS deployments were initiated ahead of schedule due to poor weather and sea conditions for MCS work. Twenty instruments were prepared for deployment on line 2, all of which were checked out and deployed without any problems. Due to a degrading sea-state, during the last eight deployments of this line instrument set-up on the deck was not done during transit (which is the normal procedure). As an instrument went over the side the next instrument to be deployed was prepped while on station. The last instrument of the line was deployed at 16:56 in Friday, Nov. 23; a summary of deployment parameters can be viewed in Table 3.

Recovery of all instruments began on Tuesday, Nov. 27 at 00:12. Recovery of all instruments became quite routine and no problems occurred during this phase. No "risers" were used during this deployment – with this success in instrument recoveries it was decided that the "risers" would not be used in future experiments. During daylight hours on the 27th the fast rescue boat was used to expedite recovery of instruments. All instruments were on-board by 12:21 on Wednesday, Nov. 28 and we subsequently proceeded to Fremantle, Australia. During recovery instrument Echidna (s/n 22 – site 6) was accidentally reset before the clock drift could be recorded. Thus, the clock drift was estimated based upon the recorded drift rate of this instrument during deployment on line 1. A summary of clock drifts and data recorded is shown in Table 4.

DATA REDUCTION

Raw L-cheapo data was converted to standard SEG-Y format as instrument gathers upon completion of each deployment. Air-gun shot files from the Ewing for individual lines were used to record section the data for the seismometer and hydrophone channels. Record sections were then transferred to the computers of the science party who began data analysis and plotted record section during the cruise. Preliminary velocity profiles were obtained mid-cruise which aided in interpretation of seismic sections. SEG-Y record sections were stored on disk as well as burned on CD for archival. The quality of the data was excellent – the Chief Scientist and co-principle investigators were very pleased with the data.

TABLE 1. EW0113 - DEPLOYMENT 1 INFORMATION

Instrument Name	Site Number	Data Logger #	Data Start Time (UTC)	Data Stop Time (UTC)	Latitude	Longitude	Water Depth (m)
BANDICOOT	1	13	11/02/01 07:00	11/06/01 08:14	19° 50.967' S	112° 14.902' E	1448
BILBY	2	18	11/02/01 09:00	11/06/01 09:57	19° 45.598' S	112° 08.068' E	1747
CORELLA	3	17	11/02/01 10:00	11/06/01 11:37	19° 40.169' S	112° 01.335' E	1902
CURRAWONG	4	3	11/02/01 11:00	11/06/01 13:30	19° 34.705' S	112° 54.620' E	1965
DEVIL	5	9	11/02/01 12:00	11/06/01 15:21	19° 29.390' S	111° 47.770' E	2220
ECHIDNA	6	7	11/02/01 13:00	11/06/01 17:26	19° 23.984' S	111° 40.995' E	2568
EMU	7	22	11/02/01 15:00	11/06/01 19:28	19° 18.590' S	111° 34.280' E	2902
GALAH	9	19	11/02/01 15:00	11/07/01 01:46	19° 07.807' S	111° 20.700' E	3913
JOEY	10	21	11/02/01 18:00	11/07/01 03:52	19° 02.386' S	111° 13.854' E	3358
KANGAROO	11	23	11/02/01 19:00	11/07/01 06:25	18° 57.003' S	111° 07.193' E	3847
KOALA	12	24	11/02/01 20:00	11/07/01 09:13	18° 51.591' S	111° 00.386' E	4588
KOOKABURRA	13	31	11/02/01 21:00	11/07/01 12:09	18° 44.574' S	110° 51.541' E	4630
NUMBAT	14	12	11/02/01 22:00	11/07/01 16:11	18° 37.507' S	110° 42.693' E	4054
POSSUM	16	6	11/03/01 00:25	11/07/01 21:25	18° 23.288' S	110° 24.970' E	4626
POTAROO	17	32	11/03/01 01:30	11/08/01 00:29	18° 16.175' S	110° 16.166' E	5017
QUOKKA	18	4	11/03/01 03:00	11/08/01 03:37	18° 09.186' S	110° 07.366' E	5201
QUOLL	19	27	11/03/01 04:00	11/08/01 06:56	18° 02.101' S	109° 58.581' E	5250
SKIPPY	20	14	11/03/01 05:00	11/08/01 09:57	17° 54.975' S	109° 49.780' E	5258
THYLACINE	21	26	11/03/01 06:30	11/08/01 13:09	17° 47.970' S	109° 41.002' E	5474
WALLABY	22	20	11/03/01 07:00	11/08/01 16:33	17° 40.912' S	109° 32.164' E	5599

TABLE 2. EW0113 Deployment 1 - TIME OFFSETS

SITE NAME	SITE NO.	D/L NO.	DEPLOYMENT	RECOVERY	TIME TAG(ms)	OFFSET(ms)	CLOSING BLOCK	COMMENT
BANDICOOT	1	13	11/02/01 04:42	11/06/01 08:11	3.449	3.449	527281	OK
BILBY	2	18	11/02/01 06:09	11/06/01 09:55	2.927	2.927	525785	OK
CORELLA	3	17	11/02/01 06:53	11/06/01 11:37	3.56	3.56	529443	OK
CURRAWONG	4	3	11/02/01 08:02	11/06/01 13:29	998.013	-1.987	534195	OK
DEVIL	5	9	11/02/01 08:44	11/06/01 15:20	999.064	-0.936	538809	OK
ECHIDNA	6	7	11/02/01 10:08	11/06/01 17:23	5.197	5.197	544701	OK
EMU	7	22	11/02/01 11:23	11/06/01 19:28	5.143	5.143	544913	OK
EURO	8	16	11/02/01 12:07					NO RESPONSE
GALAH	9	19	11/02/01 13:22	11/07/01 01:44	997.731	-2.269	573585	OK
JOEY	10	21	11/02/01 14:27	11/07/01 03:51	992.851	-7.149	573585	OK
KANGAROO	11	23	11/02/01 15:51	11/07/01 06:24	997.039	-2.961	582533	OK
KOALA	12	24	11/02/01 16:42	11/07/01 09:12	4.91	4.91	592291	OK
KOOKABURRA	13	31	11/02/01 17:53	11/07/01 12:08	984.075	-15.925	602805	OK
NUMBAT	14	12	11/02/01 18:58	11/07/01 16:10	1.731	1.731	619245	OK
PLATYPUS	15	10	11/02/01 20:22	11/07/01 18:39	3.225	3.225	0	NO DATA
POSSUM	16	6	11/02/01 21:22	11/07/01 21:24	3.662	3.662	634477	OK
POTAROO	17	32	11/02/01 22:25	11/08/01 00:29	986.154	-13.846	645245	OK
QUOKKA	18	4	11/02/01 23:39	11/08/01 03:36	998.522	-1.478	654115	OK
QUOLL	19	27	11/03/01 00:51	11/08/01 06:53	972.672	-27.328	666597	OK
SKIPPY	20	14	11/03/01 02:07	11/08/01 09:55	5.356	5.356	677573	OK
THYLACINE	21	26	11/03/01 03:21	11/08/01 13:09	969.518	-30.482	686863	OK
WALLABY	22	20	11/03/01 04:49	11/08/01 16:31	991.482	-8.518	688273	OK
WOMBAT	23	15	11/03/01 05:39					NO RESPONSE

TABLE 3. EW0113 - DEPLOYMENT 2 INFORMATION

Instrument Name	Site Number	Data Logger #	Data Start Time (UTC)	Data Stop Time (UTC)	Latitude	Longitude	Water Depth (m)
BANDICOOT	1	13	11/22/01 13:30	11/26/01 18:23	22° 01.285' S	110° 43.668' E	5135
BILBY	2	18	11/22/01 15:00	11/26/01 21:14	22° 06.782' S	110° 50.510' E	5139
CORELLA	3	17	11/22/01 16:00	11/27/01 00:04	22° 12.294' S	110° 57.292' E	5131
CURRAWONG	4	3	11/22/01 17:00	11/27/01 02:59	22° 17.749' S	111° 04.043' E	5156
DEVIL	5	9	11/22/01 19:00	11/27/01 04:16	22° 23.342' S	111° 10.923' E	5151
ECHIDNA	6	22	11/22/01 21:30	11/27/01 04:37	22° 28.815' S	111° 17.723' E	5146
EMU	7	7	11/22/01 22:30	11/27/01 07:19	22° 34.346' S	111° 24.516' E	5119
GALAH	8	19	11/23/01 2:00	11/27/01 08:19	22° 39.846' S	111° 31.393' E	5119
JOEY	9	21	11/23/01 3:00	11/27/01 10:07	22° 45.322' S	111° 38.313' E	5070
KANGAROO	10	23	11/23/01 4:00	11/27/01 14:09	22° 50.852' S	111° 45.076' E	4816
KOALA	11	24	11/23/01 5:00	11/27/01 16:33	22° 56.364' S	111° 51.867' E	4116
KOOKABURRA	12	31	11/23/01 7:00	11/27/01 19:03	23° 01.885' S	111° 58.754' E	3555
NUMBAT	13	12	11/23/01 7:00	11/27/01 20:49	23° 07.400' S	112° 05.588' E	2312
POSSUM	14	6	11/23/01 8:00	11/27/01 22:25	23° 12.929' S	112° 12.460' E	1495
POTAROO	15	32	11/23/01 10:00	11/27/01 23:50	23° 18.474' S	112° 19.329' E	1259
QUOKKA	16	5	11/23/01 11:00	11/28/01 01:25	23° 23.936' S	112° 26.204' E	1110
QUOLL	17	27	11/23/01 14:00	11/28/01 02:41	23° 29.431' S	112° 33.009' E	911
SKIPPY	18	14	11/23/01 16:00	11/28/01 03:53	23° 34.912' S	112° 39.859' E	647
THYLACINE	19	26	11/23/01 18:00	11/28/01 06:27	23° 40.492' S	112° 46.816' E	389
WALLABY	20	20	11/23/01 23:00	11/28/01 06:39	23° 45.970' S	112° 53.688' E	210

TABLE 4. EW0113 Deployment 2 - TIME OFFSETS

SITE NAME	SITE NO.	D/L NO.	DEPLOYMENT	RECOVERY	TIME TAG(ms)	OFFSET(ms)	CLOSING BLOCK	COMMENT
BANDICOOT	1	13	2001:326:11:24	2001:330:18:22	3.114	3.114	547141	OK
BILBY	2	18	2001:326:12:28	2001:330:21:13	1.374	1.374	554433	OK
CORELLA	3	17	2001:326:13:52	2001:331:00:04	3.022	3.022	564439	OK
CURRAWONG	4	3	2001:326:15:32	2001:331:02:58	995.877	-4.123	574981	OK
DEVIL	5	9	2001:326:16:48	2001:331:04:15	998.673	-1.327	571025	OK
ECHIDNA	6	22	2001:326:18:03	2001:331:04:37	5.000	5.000	559249	estimated drift
EMU	7	7	2001:326:19:11	2001:331:07:18	8.650	8.650	568441	OK
GALAH	8	19	2001:326:20:51	2001:331:08:18	996.261	-3.739	554905	OK
JOEY	9	21	2001:326:22:06	2001:331:11:14	995.971	-4.029	565339	OK
KANGAROO	10	23	2001:326:23:27	2001:331:14:08	996.295	-3.705	575837	OK
KOALA	11	24	2001:327:01:07	2001:331:16:32	5.781	5.781	583257	OK
KOOKABURRA	12	31	2001:327:01:51	2001:331:19:02	984.240	-15.760	585965	OK
NUMBAT	13	12	2001:327:04:58	2001:331:20:49	2.112	2.112	595577	OK
POSSUM	14	6	2001:327:05:52	2001:331:22:24	3.662	3.662	598793	OK
POTAROO	15	32	2001:327:07:24	2001:331:23:49	987.767	-12.233	595643	OK
QUOKKA	16	5	2001:327:08:51	2001:332:01:24	999.054	-0.946	598781	OK
QUOLL	17	27	2001:327:12:06	2001:332:02:40	975.111	-24.889	589403	OK
SKIPPY	18	14	2001:327:13:12	2001:332:03:53	4.616	4.616	585123	OK
THYLACINE	19	26	2001:327:15:37	2001:332:05:26	977.106	-22.894	583085	OK
WALLABY	20	20	2001:327:18:03	2001:332:06:37	997.919	-2.081	562131	OK