U.S.-JAPAN MARINE GEOPHYSICAL STUDY OF THE SOLOMON ISLAND ARC - ONTONG JAVA PLATEAU CONVERGENT ZONE, SOUTHWEST PACIFIC OCEAN

U. S. - JAPAN MARINE GEOPHYSICAL STUDY OF THE SOLOMON ISLAND ARC - ONTONG JAVA PLATEAU CONVERGENT ZONE, SOUTHWEST PACIFIC OCEAN

A COLLABORATIVE STUDY

BY

INSTITUTE FOR GEOPHYSICS, UNIVERSITY OF TEXAS AT AUSTIN

OCEAN RESEARCH INSTITUTE, UNIVERSITY OF TOKYO

CHIBA UNIVERSITY, TOKYO, JAPAN

LAMONT-DOHERTY EARTH OBSERVATORY, COLUMBIA UNIVERSITY

MINISTRY OF WATER, ENERGY, AND MINERAL RESOURCES, SOLOMON ISLANDS

PART I - TECHNICAL INFORMATION (PLEASE DISTRIBUTE FREELY)

PART II - PRELIMINARY SHIPBOARD SCIENTIFIC RESULTS (PLEASE RESTRICT DISTRIBUTION TO UTIG, ORI AND CU PARTICIPANTS)

Seismicity in the Solomons region by E. Araki

Review of crustal structure by S. Miura

2-D modeling of gravity anomalies along Line 1 by N. Takahashi and M. Shinohara

Ontong Java Plateau crust, plate flexure and gravity by K. Suyehiro

Identifying basement on seismic reflection data from the southwestern margin of the Ontong Java Plateau by A. Teagan

Ontong Java Plateau by M. Coffin

Statements by shipboard participants on how they would like to use data collected during EW95-11

November, 1995

CRUISE REPORT FOR EW95-11

U. S.-JAPAN MARINE GEOPHYSICAL STUDY OF THE SOLOMON ISLAND ARC-ONTONG JAVA PLATEAU CONVERGENT ZONE, SOUTHWEST PACIFIC OCEAN

Honiara, Solomon Islands - Suva, Fiji

10/17/95 (JD 289) - 11/19/95 (JD 323)

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R/V MAURICE EWING

TABLE OF CONTENTS

MAGNETIC SURVEY BY N. TAKAHASHI AND S. MIURA

INTRODUCTION AND HISTORY OF EW95-11 PROJECT

This report describes the methods and preliminary results of multichannel seismic and OBS cruise EW95-11 on the RV Maurice Ewing to the Solomon Islands during October 17-November 19, 1995. In accord with the RV Maurice Ewing ship users manual (Rev. 3, 1994), this preliminary cruise report will be distributed to the Office of Marine Affairs who will insure its distribution to concerned parties. This report is accompanied by the UNOLS Research Vessel Cruise Assessment Form and the UNOLS Cruise Report/Ship Utilization Data Report.

The Solomon Islands is located along the active convergent plate boundary between the Pacific and Australia plates (Fig. 1). Late Neogene collision of the Ontong Java Plateau, the world's largest oceanic plateau (Fig. 1, inset), with the Solomon island arc make this region a promising area to investigate the formation of oceanic plateaus (Fig. 1, inset) and collisional processes associated with the subduction of plateaus at convergent margins.

The project was initiated by Mann, Coffin, and Shipley (University of Texas at Austin Institute for Geophysics - UTIG) with a proposal submitted to the Marine Geology and Geophysics program of the U. S. National Science Foundation in the fall of 1992. Ship time was requested on the RV Maurice Ewing through a subcontract with Lamont-Doherty Earth Observatory of Columbia University (LDEO). A parallel proposal for OBS experiment during the multichannel survey was submitted to the Japanese Ministry of Education by Suyehiro (Ocean Research Institute of the University of Tokyo - ORI) and Shinohara (Chiba University, Japan - CU) at the same time as the NSF proposal. The NSF proposal from UTIG and accompanying LDEO subcontract for use of the RV Maurice Ewing was turned down while the Japanese OBS submission was fully funded in April of 1993.

Multichannel seismic study

A revised version of the NSF proposal submitted by UTIG and an accompanying subcontract submitted by LDEO in the spring of 1993 was approved for funding when ship time on the RV Maurice Ewing became available. Additional funded programs on the RV Ewing in Central America, California, the Bering Sea, Taiwan and the Woodlark basin permitted scheduling the Solomon Islands program in October and November of 1995. Funding to start the UTIG program and LDEO subcontract became available on June 1, 1995 and extends through May of 1998.

1994 Japanese-funded, passive OBS pilot study near the Russell Islands

Under a time constraint to spend their OBS funding beginning in April of 1993 from the Japanese Ministry of Education, Suyehiro and Shinohara conducted a ten day pilot OBS study of the area of the Russell Islands, Solomon Islands, in August and September of 1994. The experiment recorded over 100 earthquakes ($0.8 < M < 3.2$) along the San Cristobal and North Solomon subduction zones on five OBSs jointly owned by ORI and CU (Fig. 2). OBSs were deployed and recovered in heavy seas using the SS *Solomon Sea*, a 25 m long fishing boat operated by Blue Lagoon Cruises of Honiara, Solomon Islands, and chartered mainly for use by sport divers. The OBSs recorded data for six days and were all recovered without incident. A report of preliminary results of the pilot OBS study is given below and will be reported on in a talk at the fall meeting of the American Geophysical Society in December, 1995.

Cruise preparations in Honiara, Guadalcanal, October, 1995

The ORI-CU group arrived in Honiara, the governmental capital and largest city in the Solomon Islands, on October 7 to assemble the OBS instruments that were sent by ship from Tokyo to Honiara on August 14, 1995. As they had done for their 1994 study in the Russell Islands, they used the facilities of the Ministry of Energy, Water and Mineral Resources (MEWNR) as a staging area for the storage and assembly of the OBSs. Assembly required about 7 days of concentrated effort on the part of the five man group led by Suyehiro and

Shinohara. MEWNR provided extensive cooperation during both the assembly phase and provided a truck to transport the OBSs about 2 km to the dock to be loaded on the Ewing.

Mann arrived in Honiara on Monday, October 9 to meet with Donn Tolia, the director of MEWNR, and Mike Petterson, a geologist from the British Geological Survey working since 1992 with the MEWNR on the land geology of Malaita, Santa Isabel, and Makira. Petterson had also led several groups of petrologists from universities in the US (U. Hawaii, Notre Dame), the UK (Leicester) and Australia (Australian National University) on sampling and mapping trips to onland exposures on Ontong Java Plateau rocks on these islands. Tolia and Petterson were extremely cooperative and proved a valuable source of published and unpublished reports and maps on the land geology of this area. Following the arrival of Shipley, Coffin, Teagan, Phinney and Cowley from UTIG on Saturday, October 14, Petterson made a one hour slide presentation on the geology of the Solomon Islands to Mann and the three UTIG graduate students who were preparing reports on the onland geology. Mann made a 45 minute presentation to the staff of the MEWNR on a previous project he and Fred Taylor (UTIG) made in collaboration with MEWNR geologists on the Quaternary uplift history of the New Georgia Islands.

Mann was also assisted by Mr. Lynston Tivuru, a geologist with MEWNR and the observer on EW95-11, in locating recent tide tables from the Maritime Ministry as well as the locations of moored "fish attraction devices" or "FADs" from the Ministry of Fisheries. These small wooden rafts are used to attract small fish which in turn attract larger, more economical fish to the raft areas. The FADs are moored by either rope or chain that pose a significant threat to the seismic streamer, gun array and magnetometer towed behind the Ewing. Over 300 FAD locations were provided; 30 of these locations were close to our lines and were plotted and successfully avoided by the deck crew of the Ewing.

Tivuru assisted Mann in making public service announcements on the Solomons radio network and in two Honiara newspapers concerning the objectives and route of the EW95-11 cruise. These annoucements also warned other shipping away from crossing towed equipment behind the ship. These warnings were broadcast while the ship operated in the more confined and heavier traffic areas of the Iron Bottom Sound west of Honiara. Ship traffic proved to be light in the EW95-11 study area and was not a problem for navigation.

EW95-11 Participants

The science party and ship's crew of EW95-11 totaled 42. Nationalites represented in this group included the USA (31), Japan (5), Indonesia (1), Ireland (1), Solomon Islands (1), Fiji Islands (1), Chile (1), and Canada (1). The science party consisted of 20 individuals representing five different institutions in the U. S., Japan and the Solomon Islands.

University of Texas at Austin Institute for Geophysics (UTIG) and Department of Geological Sciences (DOGS), USA

Dr. Paul Mann, Co-chief scientist UTIG
Dr. Mike Coffin, Co-chief scientist UTIG
Dr. Tom Shipley, Co-chief scientist UTIG
Mr. Shane Cowley, Graduate research assistant DOGS, MA aspirant
Mr. Eric Phinney, Graduate research assistant DOGS, MA aspirant
Ms. Alison Teagan, Graduate research assistant DOGS, MA aspirant

Ocean Research Institute, University of Tokyo, Japan

Dr. Kiyoshi Suyehiro, Co-chief scientist
Dr. Narumi Takahashi, Post-doctoral fellow
Mr. Eiichiro Araki, Graduate research assistant, MS aspirant

Department of Earth Sciences, Chiba University, Japan

Dr. Masanao Shinohara, Co-chief scientist
Mr. Seiichi Miura, Graduate research assistant, Ph.D. aspirant

Lamont-Doherty Earth Observatory of Columbia University, New York, USA
Mr. Bruce Francis, Science officer
Mr. John DiBernardo, Technician (airguns)
Mr. Carlos Alvarez, Technician (airguns)
Mr. Chris Leidhold, Technician (electrical)
Mr. Ropate Maiwiriwiri, Technician (airguns, coring)
Mr. Michael Wittreich, Technician (airguns)
Mr. Stefanus Budhypramono, Computer systems manager
Mr. Paul Osgard, Technician (airguns)

Crew of RV Maurice Ewing
Captain Ian Young, Master
Mr. Stan Ziegler, Chief mate
Mr. Mark Landow, First mate
Mr. Jeff Sylvia, Second mate
Mr. Blaine Heinze, Boatswain
Mr. John Shank, A/B
Mr. Larry Barros, A/B
Mr. Richard Thomas, A/B
Mr. Rick Wyatt, O/S
Mr. Allen Perry, O/S
Mr. Albert Karlyn, Chief engineer
Mr. Albert Walsh, First engineer
Mr. William Moran, Second engineer
Mr. Paul Mutina, Third engineer
Mr. Guillermo Uribe, Oiler
Mr. Mark Christian, Oiler
Mr. John Schwartz, Electrician
Mr. Frank Paloney, Steward
Mr. Tim Hummel, Cook
Ms. Carole Bryant, Utility
Mr. Robert Powell, Radio operator

Science watches

Round the clock watches in the science lab were maintained according to the following schedule:

Watch leaders:
0000-0600 Suyehiro
0600-1200 Coffin
1200-1800 Mann
1800-0000 Shipley

Watchstanders:
12-4 Cowley, Takahashi
4-8 Eiichiro, Tivuru, Teagan
8-12 Miura, Phinney, Shinohara

Ship

Specifications

The 72 m long RV Maurice Ewing is an oceanographic research vessel operated by the Lamont Doherty Earth Observatory of Columbia University. The Marine Operations Office that administers the ship is located on the campus of LDEO in Palisades, New York. The ship's port of registry is New York, New York, its gross tons are 1978.63 and its net tons are 593.59.

The Ewing has the largest airgun capacity available in the US-based UNOLS fleet for MCS and OBS operations and is capable of deploying up to 5 km of digital streamer. Its service speed is 12 knots and it is designed to carry a complement of 50 persons. It was built as an industry seismic vessel in Quebec in 1983 and was converted to academic use in 1990.

Ship spaces and equipment on Deck C used for science operations

The science lab was used for watch standing and as a general work area. The analytical lab adjacent to the science lab was used to disassemble OBS instruments. The wet staging area was used to store crates used to ship the OBS instruments to and from Japan. The CTD staging room with direct access to the waist deck area and side A-frame was used as a staging area for deploying OBSs. The side A-frame and one capstan on the rear deck were used with a block and tackle to deploy and recover OBSs.

OBS OPERATIONS BY M. SHINOHARA

Location of OBS study and relation to Russell Islands study area

Deployment of 18 OBS instruments of the Ocean Research Institute and Chiba University began during EW95-11 on Tuesday, October 17 at 8 pm local time and lasted about 28 hours along a 464 km long transect (Line 1) across the Australia plate (Woodlark basin), San Cristobal trench, Solomon volcanic arc, Malaita antclinorium, North Solomon trench, and southeastern Ontong Java Plateau (Fig. 2). Line 1 was adjacent and crossed the area of the 1994 Russell Islands OBS study (Fig. 2).

Geologic provinces and water depths of OBSs

The 18 OBSs were deployed on four distinct tectonic provinces decided in June of 1995 during a pre-cruise visit by Suyehiro and Shinohara to UTIG:

• oceanic **Australian plate** subducting at San Cristobal trench (SAT 1-3) (Fig. 4). This area of the subducting plate appears to represent a thin eastward extension of the Woodlark oceanic basin formed between the Louisiade Plateau and an area now subducted at the San Cristobal trench about 5 Ma ago (Taylor et al., 1995). Water depths range from 4350 to 4843 m. OBSs were not deployed far enough south to include the continental or oceanic plateau crust of the Louisiade Plateau (Fig. 4).

• **Solomon volcanic arc province** between San Cristobal trench and Indispensable fault zone (SAT 4-9). This area is believed to have in an arc setting from early Tertiary to Recent times (Petterson, 1995). Water depths range from 186 to 2867 m.

• **Malaita anticlinorium or Solomon Pacific province** between the Indispensable fault zone and the North Solomon trench (SAT 10-13). This area is believed to be the obducted and deformed edge of the Cretaceous-Tertiary Ontong Java Plateau (Petterson, 1995). Water depths range from 493 to 2433 m.

• **Ontong Java Plateau** north of the North Solomon trench (SAT 14-18). This region is known to be underlain by an oceanic plateau of Cretaceous age (Petterson, 1995). Water depths range from 1645 to 3191 m.

Graphical representations of seafloor relief are compared for all sites in Figure 5. The roughest seafloor topography is associated with young, unsedimented oceanic crust of the Woodlark basin at sites SAT-2 and 3.

OBS description

A schematic showing the design of the OBSs used by ORI and CU since 1991 is shown in Figure 6. Each OBS is equipped with a three-component 4.5 Hz velocity sensitive geophone (Mark Products L-25B). Data are recorded on a Sharp digital audio tape (DAT) recorder capable of effectively recording about 1.2 GB. 1.2 GB of storage capacity is equivalent to about

17-day continuous recording of 4 channels of 16-bit data samples at an A/D sampling rate of 100Hz. In this experiment two channels were alloted to the vertical component sensor outputs after amplifications of x1000 and x5000. The remainig two channels recorded horizontal sensor outputs amplified by a factor of 1000. These factors were determined based on the ambient noise level during the previous OBS experiment in the Russell Islands pilot study conducted in August and September of 1994 (Fig. 2).

The OBS is a free-fall, pop-up-type housing all the components in a 17" Benthos glass sphere (Fig. 6). The glass sphere has positive buoyancy and is released by acoustic command from the heavy metal base. The external mechanical design is the same as a successful analog OBS designed by T. Kanazawa at the University of Tokyo. The instrument is designed so that bottom currents, if any, will have minimum effect on the seismic records. The heavy metal stand is released by the OBS instrument and left on the seafloor. The antenna is attached to a radio beacon which aids finding the OBS on the sea surface but is designed in a position to reduce noise related to deep sea currents on the sea floor.

OBS deployment procedure

OBS's were launched from the starboard waist deck by the five member Japanese team (Fig. 7). The OBS was hoisted to a height of about 1.5 m using a capstan on the rear deck. A rope fed through a block and tackle led from the capstan to the OBS at the waist deck. Two people were used at the capstan with one running the capstan and the other taking up slack rope. Another person operated the A frame which was lowered to allow the OBS to swing freely from the side of the ship. Two guide ropes were looped to the OBS to steady it while suspended. A third rope was used to open a release that allowed the OBS to drop into the water. The bridge informed the group when the GPS-navigated point was reached and the OBS was released to within approximately 10 m of this point. The latitude and longitude of the drop site was recorded in the science lab along with the water depth at each site.

The average ship speed between OBS sites during deployment was 11 knots. The time required to launch an OBS and move to the next site averaged 1.5 hours. OBS deployment times and water depths are summarized on Table 1.

Recording time and pick up time

The recording time of the OBSs was set from 6 am on October 19 to about 6 am on November 5. OBS clocks have the capacity for keeping time for more than 35 days. The recovery days were November 2 and 3 in order to overlap OBS recovery with an unscheduled port call to Honiara to pick up streamer spares.

Recovery of OBS's started on Wednesday, November 1 at 8 pm local time from the southwestern end (Table 2). It took 51 hours to recover 17 instruments. One instrument, SAT#2, made no reply to acoustic signals. SAT#2 was located on the rough, young oceanic crust of the Woodlark basin (Fig. 4). An unsuccessful effort was made to receive signals from SAT#2 from a position approximately 100 km west of its site during the last seismic line of the cruise on November 12.

OBS recovery procedure

An acoustic transponder system on each OBS provides a communication link with the ship (Fig. 6). When the OBS receives the weight release command from the ship, electric current fed from lithium batteries (12V) starts to flow through seawater between electrodes (Fig. 7). This electric current corrodes away the stainless steel plates holding the weights. Electrolytic dissolution takes about 12 minutes or longer depending on the strength of current flow through seafloor sediments in which the base is enclosed (Table 2).

Immediately above the deployment site, an acoustic transducer was lowered from the waist deck of the *Ewing* to call the OBS and send the weight release command. Normally, the first call activates the OBS transponder and subsequent calls give slant range readings. Once the OBS response is confirmed, the weight release command is sent. After electrolytic dissolution has separated the OBS from its stand, the OBS starts its ascent to the sea surface at

Table 1: OBS deployment data on EW95-11

Site Code	OBS No.	Rec. Type	Trp. Code	Trans. Freq.	Date	Time	Lat. (deg, min)		Lon. (deg, min)		Depth
SAT#1	OBS-D	DAT2	2D-1	40.100	10/17/95	20:15	10	00.076	158	28.062	4843
SAT#2	OBS-H	DAT2	1B-2	43.528	10/17/95	21:57	9	50.289	158	39.590	4380
SAT#3	OBS-A	DAT2	4A-1	160.725	10/18/95	00:16	9	40.6865	158	51.2845	4350
SAT#4	OBS-E	DAT2	3D-1	40.100	10/18/95	01:53	9	30.9205	159	02.826	2867
SAT#5	OBS-F	DAT2	2A-1	43.528	10/18/95	03:23	9	21.1950	159	14.490	1844
SAT#6	OBS-B	DAT2	1D-1	160.785	10/18/95	05:08	9	11.596	159	25.991	575
SAT#7	OBS-G	DAT2	2B-2	40.000	10/18/95	06:40	9	1.747	159	37.697	1359
SAT#8	OBS-Q	V1.7	1A-1	43.525	10/18/95	08:05	8	52.091	159	49.277	573
SAT#9	OBS-C	DAT2	3B-1	159.480	10/18/95	09:30	8	42.415	160	0.836	186
SAT#10	OBS-P	V1.7	1A-1	40.200	10/18/95	10:54	8	32.698	160	12.412	1927
SAT#11	OBS-R	V1.7	2C-1	43.535	10/18/95	12:18	8	23.004	160	24.045	1053
SAT#12	OBS-O	V1.7	1A-1	160.725	10/18/95	13:40	8	11.413	160	32.881	2433
SAT#13	OBS-N	V1.7	2C-3	40.100	10/18/95	15:01	7	59.869	160	41.698	493
SAT#14	OBS-M	V1.7	3A-1	43.528	10/18/95	16:24	7	48.316	160	50.580	3191
SAT#15	OBS-J	V1.7	2C-3	154.585	10/18/95	17:47	7	36.696	160	59.462	2544
SAT#16	OBS-K	V1.7	1B-2	43.535	10/18/95	19:14	7	25.085	161	08.360	1878
SAT#17	OBS-L	V1.7	4D-1	160.785	10/18/95	20:42	7	13.603	161	17.140	1645
SAT#18	OBS-I	V1.7	2A-1	159.480	10/18/95	22:05	7	02.003	161	26.004	1717

DAT2: DAT-2 Ver.1.0 (New version)
V1.7: DAT-1 Ver.1.7 (Old version)
Date and time are local (Local time = UTC + 11h)
Positions were determined by Trimble SVeeSix GPS unit

a rate of 0.75 m/s rate (Fig. 7). Acoustic ranging is made continuously from the ship during its ascent. Because the ship commonly drifts away from the OBS site during the ascent of the OBS, the transducer is pulled on to deck about 30 minutes before the scheduled surface time of the OBS. This 30 minute period is devoted to slowly maneuvering the ship at a speed of 2-3 knots to the deployment site.

When an OBS breaks the sea surface, it begins to emit radio signals on a 40 or 160 MHz band and flash a strobe light if it is nighttime. The bridge would position the ship on the downwind side of the OBS in order for the OBS to drift alongside the waist deck on the starboard side of the ship. A pole with a hook attached at its tip was used to grasp the wire loop on the OBS. While holding the OBS with this hook, another hook with a rope threaded through a block and tackle on the side A-frame crane at the waist deck was latched onto the same wire loop to haul the OBS onto the deck. It took less than 20 minutes to find most of the 17 OBSs and pull them onto deck. On the deck, the OBS is rinsed by fresh water.

Seas were moderately heavy during the recovery of OBSs 1-7 in the area southwest of Guadalcanal that is fully exposed to prevailing southeasterly winds. However, rougher seas did not significantly affect the recovery times (Table 2).

OBS disassembly and data recovery

The internal OBS clock was immediately calibrated against the master clock upon recovery. Disassembly of each OBS followed several hours after recovery when the temperature within the enclosed glass sphere had equilibrated with room temperature on the ship. Downloading of EW95-11 data includes opening the glass sphere and removing DAT tapes. Tape was either completely or 99% used except in one case (SAT-10) where 90% of tape usage was attributed to a low CPU battery (Table 3). Sea water leaks were detected for two OBSs (SAT 11 and 15) and ejecting the tape was a problem for one OBS (SAT 15) (Table 3). Each OBS was on the seafloor for about 15-16 days and has recorded 14-16 days of data starting October 19 at 6 am (local time) (Table 3).

Airgun control system for monitoring OBS shots

It is important to record exact airgun shot times and ship positions for the EW95-11 OBS experiment. Although shot times and ship navigation data were recorded by *R/V Ewing* navigation system, we also recorded these data using an independent system to provide a backup.

The airgun array used in EW9511 consisted of 20 airguns. Total chamber volume is 8440 cubic inches. Shot time of airgun array was determined using TTL level pulse called the Time Break Echo or TBE. The TBE was sent by the airgun control system at the same time as firing the airgun array.

The airgun control system is a part of MCS recording system, and consists of REVS-2 (Radio Event Synchronization System-2), RDL3 (Radio Data Link-3), TAGS (Timing Analysis for Gun Synchronization), and CLASS (Closed Loop Automatic Source Synchronizer) (Fig. 8).

First, an internal timer of the REVS-2 sends a signal called the Nav Clock Prime, or NCP, to the navigation system and the MCS recording system through the SIB (#1 in Fig. 8). The NCP sent at an interval of about 20 seconds is indication that the MCS recording system has begun a cycle. The RDL3 makes the decision to fire the airguns using information from the TAGS, navigation system, and the MCS recording system. The MCS recording system provides a message that gives permission to fire the airguns. The navigation system gives navigation information to the RDL3. Finally, the RDL3 checks that the TAGS is in an adequate mode. If all of the criteria are met, the REVS2 sends a BLAST pulse to the CLASS at 939.36 ms after sending NCP (#2 in Figure 8). The CLASS tries to fire airguns at 64 ms after receiving BLAST. Simultaneously with firing airguns, the CLASS sends a signal called as TB (Time Break) (#3 in Figure 8). The TB is received by the SIB, and is sent back to the CLASS as TBE (Time Break Echo) by the SIB. The TBE is also distributed to the other system by the SIB. The TAGS receives an information of each airgun from the CLASS after firing airguns. The information contains the status of all airguns and timing errors about firing of each airgun. The TAGS

Table 2: OBS recovery data on EW95-11

OBS No.	Release command				OBS at surface				OBS on deck			
	Time	Lat.	Lon.	Dis.	Time	Lat.	Lon.	Depth	Time	Lat.	Lon.	Depth
SAT#1	11/1/95 19:58	10° 00.040	158° 28.042	4829	11/1/95 21:46	9° 59.624	158° 27.922	-	11/1/95 22:46	10° 00.369	158° 28.628	4786
SAT#2	11/2/95 00:35	9° 50.270	158° 39.471		SAT#2 did not reply. We left from SAT#2 at 11/2/95 03:00							
SAT#3	11/2/95 04:34	9° 40.611	158° 51.255	4306	11/2/95 06:18	9° 40.634	158° 51.248	-	11/2/95 06:42	9° 40.733	158° 50.968	4326
SAT#4	11/2/95 08:29	9° 30.875	159° 02.738	2870	11/2/95 09:25	9° 30.831	159° 02.714	-	11/2/95 09:42	9° 30.901	159° 02.779	-
SAT#5	11/2/95 11:16	9° 21.314	159° 14.631	1854	11/2/95 12:08	9° 21.185	159° 14.518	-	11/2/95 12:19	9° 21.229	159° 14.340	-
SAT#6	11/2/95 13:53	9° 11.577	159° 25.992	625	11/2/95 14:20	9° 11.341	159° 25.435	-	11/2/95 14:42	9° 11.595	159° 25.869	535
SAT#7	11/2/95 16:25	9° 01.710	159° 37.588	579	11/2/95 17:11	*9° 01.720	*159° 37.590	-	11/2/95 17:27	9° 01.785	159° 37.450	-
SAT#8	11/2/95 19:04	8° 52.033	159° 49.369	1375	11/2/95 19:28	*8° 52.006	*159° 49.232	-	11/2/95 19:44	8° 52.012	159° 49.206	1363
SAT#9	11/2/95 21:30	8° 42.460	160° 00.837	212	11/2/95 21:45	*8° 42.428	*160° 00.815	-	11/2/95 21:58	8° 42.311	160° 00.988	186
SAT#10	11/2/95 23:27	8° 32.704	160° 12.438	1916	11/3/95 00:18	*8° 32.523	*160° 12.574	-	11/3/95 00:26	8° 32.549	160° 12.560	1930
SAT#11	11/3/95 02:04	8° 23.057	160° 24.070	1055	11/3/95 02:39	*8° 23.083	*160° 24.059	-	11/3/95 02:52	8° 23.123	160° 24.048	-
SAT#12	11/3/95 04:21	8° 11.460	160° 32.855	2408	11/3/95 05:22	*8° 11.465	*160° 32.573	-	11/3/95 05:52	8° 11.593	160° 32.363	-
SAT#13	11/3/95 07:27	8° 59.888	160° 41.693	498	11/3/95 07:58	7° 59.986	160° 41.649	-	11/3/95 08:35	8° 08.362	160° 41.004	-
SAT#14	11/3/95 10:18	7° 48.471	160° 50.464	3151	11/3/95 11:35	*7° 48.396	*160° 50.436	-	11/3/95 11:50	7° 48.555	160° 50.498	3010
SAT#15	11/3/95 13:26	7° 36.747	160° 59.440	2544	11/3/95 14:29	*7° 36.638	*160° 59.331	-	11/3/95 14:46	7° 36.863	160° 59.412	-
SAT#16	11/3/95 16:17	7° 25.239	160° 08.421	1874	11/3/95 17:08	*7° 25.129	*161° 08.222	-	11/3/95 17:22	7° 25.179	161° 08.494	1887
SAT#17	11/3/95 18:54	7° 13.697	161° 17.139	1660	11/3/95 19:44	*7° 13.557	*161° 17.197	-	11/3/95 19:59	7° 13.729	161° 17.175	1647
SAT#18	11/3/95 21:33	7° 02.097	161° 25.976	1706	11/3/95 22:24	*7° 02.114	*161° 25.965	-	11/3/95 22:42	7° 02.105	161° 26.083	1715

Positions were determined by Trimble SVeeSix GPS unit
*Positions were determined by Trimble Nav Source GPS on R/V Ewing
Time is local time (Local time = UTC+11h)

TABLE 3: OBS RECORDING TIMES ON EW95-11

Sta. No.	Start Recording	End recording	Rec. ID	Tape	Ejecting tape	Remarks
SAT#1	10/19/95 06:03:00	11/01/95 19:57	87	99%	11/05/95 14:00	
SAT#2	10/19/95 06:00:30	11/02/95 00:35	90			Lost
SAT#3	10/19/95 06:02:30	11/02/95 04:32	24	End	11/05/95 15:00	
SAT#4	10/19/95 06:01:00	11/02/95 08:19	88	99%	11/05/95 15:40	
SAT#5	10/19/95 06:00:00	11/02/95 11:15	89	99%	11/05/95 16:50	
SAT#6	10/19/95 06:01:30	11/02/95 13:50	23	End	11/05/95 17:30	
SAT#7	10/19/95 06:03:30	11/02/95 16:25	25	99%	11/05/95 19:00	Moisture
SAT#8	10/19/95 06:06:30	11/02/95 19:04	8	End	11/05/95 19:40	
SAT#9	10/19/95 06:02:00	11/02/95 21:30	91	99%	11/05/95 20:10	
SAT#10	10/19/95 06:04:30	11/02/95 23:27	10	90%	11/05/95 20:50	Low CPU battery
SAT#11	10/19/95 06:08:00	11/03/95 02:03	11	End	11/05/95 21:30	Sea water leak
SAT#12	10/19/95 06:07:00	11/03/95 04:21	22	99%	11/05/95 22:20	
SAT#13	10/19/95 06:04:00	11/03/95 07:27	9	End	11/05/95 23:10	
SAT#14	10/19/95 06:08:30	11/03/95 10:18	3	End	11/05/95 23:40	Sea water leak
SAT#15	10/19/95 06:05:00	11/03/95 13:26	4	End	11/06/95 16:00	Ejecting tape trouble
SAT#16	10/19/95 06:07:30	11/03/95 16:17	2	End	11/07/95 18:20	
SAT#17	10/19/95 06:06:00	11/03/95 18:53	7	End	11/07/95 18:50	
SAT#18	10/19/95 06:05:30	11/03/95 21:23	12	End	11/07/95 19:12	

Time is local time (Local time = UTC + 11h)
Rec.ID: recorder serial number
Tape: rate of winding up DAT tape at tape ejection

displays the information at every shot and makes shot-to-shot adjustments to the firing time of each airgun for next shot. According to the TAGS report, we found that every airgun of the array was fired within 1 ms centering TBE time.

The TBE signal is distributed to our system from the SIB. The TBE is TTL level pulse with negative logic; that is, the down-going edge indicates the airgun shot time.

Shot time recording system

We determined shot times by measuring exact time of a down-going edge of a TBE pulse distributed from the SIB. To measure the shot time, we used two systems. The first system measured the time of the event using the GPS clock, and the second system records waveform of the TBE (Fig. 9). Both systems were located in the instrument room in the R/V EWING and operated simultaneously.

We used TrueTime model 505-106 timing module TMD for the GPS system. The TrueTime GPS can compute accurate time from Coarse Acquisition (C/A) signals transmitted by the GPS satellites. The antenna of the TrueTime was installed on the starboard side of the top deck on the R/V EWING. Timing accuracy of the TrueTime GPS is 2 micro seconds. The TrueTime has two modes to compute timing solution. In TIME MODE, the TrueTime disables surveying satellites by using a predetermined position and then uses only one satellite. In the other mode, SURVEY MODE, the TrueTime tracks three or four satellites and repeatedly calculates position which is used for computing timing. Therefore, the SURVEY MODE must be used for marine surveys. The TrueTime GPS has function to measure event timing. When a TTL pulse is input to the TrueTime, the TrueTime measures a time of a pulse edge using the GPS clock, and output the event time to RS232C port in the format of ASCII character. The time resolution of measure an event timing is 100 nano-seconds.

The recording system for the TrueTime was a personal computer (PC). The TBE was input to the TrueTime through a one-shot multivibrator. The PC stored the event time data to a 100 MB hard disk in ASCII characters. The PC had also ethernet interface to connect to ship's LAN. The shot times measured by our system coincide with those determined by the EWING system within 1 ms.

The other recording system recorded digital logic (high or low) of TBE signal, 1 PPS from the TrueTime GPS, and BCD 1 PPS from our master clock. The master clock was used for OBS clock calibration. These TTL level signals were input digital input ports of A/D convert module attached to the other PC. Though the A/D converter has 4 input digital ports, we use one channel to check for DMA overrun. A sampling interval is determined using an internal clock of the A/D module. We sampled data with a sampling frequency of 1 kHz, i.e. the time resolution of the data was 1 ms. The data were stored to a 300 MB MO disk. All files are listed in Table 5.

Table 4. Shot time files recorded by TrueTime System

File name	Start time		End time		File size (byte)
logfile.9	10/19/1995	15:54:41.7	10/22/1995	13:26:17.8	309,672
logfile.11	10/22/1995	14:12:43.0	10/22/1995	14:13:15.0	92
logfile.12	10/22/1995	14:41:07.6	10/28/1995	16:03:06.3	594,757
logfile.13	10/28/1995	19:41:43.3	10/31/1995	12:54:46.2	269,399

Table 5. Shot time files recorded by Digital Logic Recording System

File name	Start time		End time		File size (byte)
airgun.ew1	10/19/1995	12:20:43	10/25/1995	04:52:43	245,760,000
airgun.ew2	10/26/1995	18:16:00	10/30/1995	18:16:00	172,800,000
airgun.ew3	10/30/1995	18:17:02	10/31/1995	18:17:02	43,204,608

Table 6. Component assigned to each channel

Ch.	Component	Logic
DGI0	TrueTime 1PPS	Positive
DGI1	Master clock BCD 1PPS	Positive
DGI2	TBE	Negative
DGI3	always 1 (For check of DMA overrun)	

Ship position recording system

We recorded the ship's positions using a GPS positioning system. The GPS positioning system used is a Trimble SVeeSix 6-channel GPS Sensor whose receiver tracks up to 8 GPS satellites and automatically selects the best 4 of those satellites for computing position. As the satellites move, the receiver automatically begins tracking new satellites and continues to select the best satellites for computing position. The navigation data are digitally output over the communication channel (RS232C). The navigation data consists of ship's position (latitude, longitude, altitude), UTC time tags fixing position, PDOP, VDOP, HDOP, TDOP, and used GPS satellite numbers.

The navigation data were stored to a hard disk on a sub-note PC. The PC also controlled the GPS receiver. The ship's positions and the other data were recorded at an interval of 1 second and about 20 seconds, respectively. The antenna of Trimble GPS was mounted near the side A-Frame on starboard side of the B-deck due to due tot the shortness of the antenna cable. This location of the antenna meant that we could not get good visibility of the sky and we could not get good positions because the GPS receiver could not "see" or track many GPS satellites. The GPS receiver and the PC were set in the CTD room. All files we recorded are also listed in Table 1.

Table 7. Navigation files recorded by Trimble SVeeSix GPS system

File name	Start time		End time		File size (byte)
sol95pos.001	10/17/1995	19:07	10/22/1995	12:17	21,182,836
sol95pos.002	10/22/1995	15:06	10/22/1995	15:06	562
sol95pos.003	10/22/1995	15:07	10/25/1995	11:35	11,631,372
sol95pos.004	10/26/1995	18:22	10/31/1995	14:42	20,987,430
sol95pos.005	11/01/1995	20:14	11/03/1995	22:59	8,882,154

PROJECT OBJECTIVES FOR OBS DATA BY K. SUYEHIRO

The objectives of the ocean bottom seismographic (OBS) survey are summarized here. The principal objective is Objective 1 and the experimental design was made towards achieving this goal. Anomalous features related to plate subduction that are studied in this area are to be compared with those found in the Japan subduction zone.

Objective 1: To obtain the arc transect crustal structure from the Ontong Java Plateau through Malaita Anticlinorium, Indispensable Strait, and San Cristobal Trench to the northwestern continuation of the Pocklington Trough. The transect covers all the provinces (Ontong Java, Pacific, Central, and Volcanic Provinces) that characterize the geological history and the tectonics of the Solomon arc system. A two-dimensional crustal structure model that images down to depths of 20 km or more will be constructed. For better resolution of the deeper image, constraints from MCS data are essential.

Objective 2: To determine local hypocenters as accurately as possible. Because the OBS's were placed nearly linearly, the recording of the Honiara station (digital broadband station) must be used as well. Based on our 1994 preliminary OBS survey made in the south of the Russell Islands, hundreds of microearthquakes will be registered during the deployment period of about 15 days. Verification of and better definition of the subduction geometry is the main target.

Objective 3: To obtain a broad scale mantle heterogeneity using natural earthquake data. The subduction history of the Pacific and the Australian plates is still not unambiguously resolved. The existence of the Volcanic Province at the present location relative to the subducted plate is not easily understood. Whether the role of subduction, possibly the supply of water by dehydration of minerals into the high temperature mantle to initiate melting, is significant or not can be tested by the existence or non-existence of a highly attenuative uppermantle. In order to achieve this objective, the OBS array must have recorded local deep events as well as distant events so that the attenuative portion of the uppermantle can be mapped.

Objective 4: Search of anomalous seismic phases leading to identifications of deep seismic boundaries such as; subducting plate boundaries in the seismic and aseismic portion of the slab, sub-Moho boundaries, etc.

SOLOMON ISLANDS TRANSECT OBS DATA PROCESSING SCHEDULE (1995-6) BY K. SUYEHIRO

November, 1995

1. Make back-up copies of original DAT data tapes (SAT-1, 3-18).
2. Make time calibration tables for all OBS.

December, 1995

3. Make monitor records of selected data (8 OBS's x 15 days data).
4. Edit and make airgun data files. (Lines 1, 14B-17)
5. Determine OBS locations and check time accuracy using airgun data.

A. CONTROLLED SOURCE DATA

Data: ±100 km per OBS (4000 shots/OBS, 30 s/trace; 3ch) = 72 MB 6 OBS/CDROM

December, 1995 - January, 1996

6. Make airgun record sections. Find appropriate distance range for analysis.
7. Make CD-ROMs

February, 1996

8. At UTIG, compare MCS and OBS results. Bring OBS data CD-ROMs, record section plotting and 2-D modelling programs to UTIG. Improve on MCS velocity analysis, 2-D modelling using tau-p and forward ray-tracing.
Structure beneath LINE 1; Start from north.

March - December, 1996

9. Preliminary results: Japanese Earth & Planetary Sciences Meeting
10. Improve model
11. Prepare for AGU Fall Mtg.
12. Inverse modelling over SAT 12-14 (Malaita Anticlinorium)

B. NATURAL EARTHQUAKE DATA

December, 1995 - January, 1996

5. Identify teleseismically determined events to study: (1) uppermantle beneath the Solomon Arc (apparent velocities, attenuation), (2) plate geometry using converted and/or reflected phases.
6. Identify local events, check if HONIARA records available.
7a. Edit and make event files (include HONIARA if available).
7b. Make a CD-ROM.
1996 FEB-DEC
8. Try event location for local events.
9. Preliminary results: Japanese Earth & Planetary Sciences Meeting
10. Waveform modelling
FIG. 11 = XBT profiles (see caption for description)

MULTICHANNEL SEISMIC REFLECTION OPERATIONS
BY A. TEAGAN AND E. PHINNEY

Acquisition: Airgun array

Cruise EW95-11 collected 4050 km of multichannel seismic data in the Solomon Islands region using the seismic system aboard the RV Maurice Ewing (Fig.10). The sounds source on the Ewing is a 20 gun air gun array with a capacity of 8510 cubic inches (Fig. 13). The guns are deployed on two retractable booms that extend at right angles from the stern of the ship. The gun booms offer several advantages over linear arrays:

• the booms increase the distance between the guns and the streamer that is towed directly behind the ship and therefore reduce the problem of entangling the gun cables with the streamer.
• the booms increase the distance between the guns themselves and reduce the problem of entangling gun cables.
• catwalks and gun trollies along the booms allow individual guns to be taken off line for repairs without interrupting shots of the other guns.

As shown in Figure 12, the center of the gun array is located 39.6 m (111 feet) from the stern of the Ewing. The optimum depth of guns below the sea surface is 8 m. This depth is approximate as slower ship ships less than 4 knots cause the guns to tow deeper (~10 m) in the water and faster speeds cause them to tow closer to the surface (~6 m). Gun depths are monitored by watchstanders from a "Guns Depth Status" monitor in the science lab.

Acquisition: Streamer and recording system

The seismic system on the *Ewing* is the Digicon DSS-240 digital seismic system, which can support up to 240 channels of data. The seismic signal is recorded by hydrophones in a streamer that is towed directly behind the vessel and commonly is of 3 to 5 km in length.

A commonly used streamer configuration used for EW95-11 was 3047 m long and is shown schematically on Figure 13. The first 47 m of this streamer is an armored tow leader that is designed without hydrophones in order to avoid ship noise and to be strong enough to tow the remainder of the cable. The tow leader is followed by a 100 m long passive section that also lacks hydrophones. The hydrophones are located in the 3 km of cable farthest from the ship (Fig. 13).

The tow leader and passive section of the streamer used in this cruise was possibly damaged during the previous cruise (EW95-10) in the Woodlark basin (Papua New Guinea) when the trailing active part of the streamer became hooked on a submerged object and was stretched and subsequently sank to an unknown depth in a vertical position behind the ship. Such a situation places tremendous stresses on connections in the tow leader and passive section that may have been the source of bad connections in this part of the streamer during EW95-11. The passive sections were subsequently removed during EW95-11 because of electrical problems.

Streamer components

The streamer is composed of a number of 100 m sections, each consisting of four 25 m groups. Each group contains 14 hydrophones and comprises one data channel. Digitizing canisters, or "cans", digitize the analog signal as it is received and telemetry cans send the signal from the streamer to the recording system located in the science lab.

There are two types of sections in the Digicon streamer used for EW95-11. The older type of section uses external cans, referred to as CAN-ONEs. There is one titanium CAN-ONE per section that contains the analog to digital (A/D) converter and the telemetry can within one unit.

The newer sections used in the streamer are equipped with internal cans, or CAN-TWOs. There are five per CAN-TWOs section, four A/D converters and one telemetry unit located in the center of the section. The distribution of CAN-ONE, CAN-TWO, and birds along a 140 channel streamer are listed on Table 8.

Oil, tail buoy and birds: Maintaining streamer buoyancy

Three methods are used to keep all or parts of the streamer at an optimal depth of about 10 m below the sea surface: 1) an oil filling within the streamer cable provides it with neutral buoyancy; 2) the tail buoy keeps up the end of the streamer; and 3) depth controllers or "birds" along the length of the streamer maintain the streamer at a programmed depth.

A 50 m long tail rope following the last active section is connected to the tail buoy at the end of the streamer (Fig. 13). The purpose of the tail buoy is to keep the end of the streamer close to its ideal towing range of about 10 m.

Streamer depth controllers, or "birds", are attached by aluminum collars to the streamer and are also used to maintain this optimal streamer depth the streamer along its length. Two types of Digicourse birds used in EW95-11 are illustrated in Figures 14 and 15. The standard bird type is the Digicourse Model 5010 DigiBIRD which is 1.2 m long and is powered by four D cell lithium batteries with a 2000 hours operation period. Depth and diagnostic commands are given from science lab and transmitted along the cable to one or all of the birds. Communications take place via a DigiCOURSE DigiSCAN controller over a transmission line in the streamer.

The birds use an internally mounted transducer and can monitor depth over a range of 0 to 400 feet with an accuracy of +/- 0.5 feet. They compare the measured depth to their target depth and make the necessary adjustments. The birds control streamer depth by adjusting their wing angle, which can provide up to 35 pounds of lift at 5 knots. Batteries activate the fins of the bird in an upward dive, downward dive, or neutral position that can be monitored and set from the science lab. Birds near the rear of the streamer require more fin motions to achieve their assigned depths and therefore require double battery packs. A special type of bird, the Digicourse Model 5011 Compass Bird, is equipped with a directional compass that provides the lab with the heading of that section of the streamer. For a 3 km streamer of EW95-11, only one or two compass birds were available

Streamer configurations prior to and during EW95-11

Removal of bad sections and additions of good sections or "spares" during a cruise changes the length of the streamer and the number of active channels. In this section we summarize streamer configurations and special problems in the preceding Woodlark basin cruise (EW95-10). Information on the streamer condition during this cruise is important for a full understanding of four streamer changes during EW95-11.

Streamer configuration during the Woodlark basin cruise (EW95-10)

The history of the streamer during the 4 day JOI-USSAC sponsored site survey cruise to the Woodlark basin was described in an excellent written summary left on the ship for the PIs of EW-95-11 by the EW95-10 chief scientist, Brian Taylor (Hawaii Institute for Geophysics).

The seismic streamer remaining remaining from the Taiwan cruise (EW95-9) had 32 active sections on the reel. The two lead/stretch sections had been damaged and removed. Of the remaining sections, the front nineteen (19) were CAN-TWO, the aft thirteen (13) were

CAN-ONE with a voltage converter (60 V to 48 V) between the two types. A weighted CAN-TWO section was on a minireel on the aft deck. Eight (8) CAN-ONE sections plus 1 CAN-TWO sections were in a van on the upper deck.

A rush shipment from Digicon in Texas to Kaohshiung, Taiwan, provided EW95-10 an additional twelve (12) unfilled sections, their CAN-ONES, streamer oil and birds. The Taylor group filled the 12 sections with oil and added them to the reel during the transit from Taiwan to the Woodlark basin study area in Papua New Guinea. They also transferred eight (8) spare sections from the van to a large coil on the aft deck.

EW95-10 began streamer deployment at the Woodlark basin on October 8, 1995. Weather conditions were, and remained, perfect throughout the four day cruise. A 5200 m long streamer was deployed that contained both CAN-ONE and CAN-TWO types connected by a voltage converter. Tests of the coverter showed that the converter was working properly and the decision was made to deploy eight (8) additional sections from the deck making a total of 52 connected sections of which 25 were in the water. The 5200 m long streamer would not build with problems indicated at several different cans. Eventually a 4965 m long streamer was activated after a deployment period of 19 hours.

By the third line, the streamer would only build 37 sections with a maximum offset from the guns of 3725 m. This amount is 500 m less than the Ewing standard of 4225 m and 1500 m less than the proposed length of 5225 m. The 37 sections are configured in 4 X 25 m groups with a total of 148 channels. Of these channels, three give no response, two are very weak (one is in a seawater filled section) and two in the same section are > 600 uB in noise.

Taylor completed the minimum MCS site survey requirements in their study area and was shooting an extra line in the remaining 4 to 6 hours of his survey when the streamer hit an unidentified submerged object that raked along the last 15 sections. The object was thought to be a tree, perhaps floating vertically in the water.

The problem was noted immediately and the ship was turned to retrieve and check on the streamer within 15 minutes. The aft third of the 4900 m long streamer had lost its birds, filled with water and sank filling some cans with water and imploding the tail buoy. All remaining sections were recovered.

According to Captain Young, the raking and shredded damage to the recovered part of the streamer suggested that it had been pulled through a narrow opening - perhaps the roots of a tree standing vertically in the water.

The remaining part of the EW95-10 was devoted to a 3.5 and 12 kHZ survey of the Moresby seamount area along with piston coring and dredging.

Streamer configuration during the Solomon Islands cruise (EW95-11)

EW95-11 used four different streamer configurations that ranged from 28 to 32 sections (Fig. 16). The different streamer configurations subdivide the cruise into four phases.

Phase 1 parameters (Lines 1-19)

The first streamer configuration of Phase 1 used a 3047.2 m long streamer that resulted in seismic lines 1-19 of the cruise (Fig. 17A). The streamer contained 29 active, 100 m long sections (18 CAN-TWOs and 12 CAN-ONEs), for a total of 116 channels (Fig. 16). A 47.2 m armored tow leader connected to the streamer to its reel/level wind assembly on the back deck. The tow leader is followed by a 100 m passive section.

The distance from the stern to the center of the near channel (channel 116) is 159.7 m. The source-receiver offset is 120.1 m for the near trace (channel 116) and 2995.1 m for the far trace (channel 1). Ten birds were distributed at equal spacings along the streamer at sections 1, 4, 7, 10, 14, 17, 20, 23, 26 and 29.

Known bad channels were identified from shot gathers during Phase 1 are channels 116, 115, 87, 85, 80, 55, 50 and 3. Bad channels are characterized by excessive noise, contain energy spikes, or did not record any data at all.

The buoyancy of the end one third of the Phase 1 streamer progressively deteriorated particularly after the disappearance of two birds near the end of Line 13 near Malaita. The

LDEO science staff were able to add three birds to the end of the streamer using the rescue boat. This measure stabilized the streamer depth until the end of Phase 1.

Phase 2 parameters (Lines 20-31)

For the second phase of the MCS, eleven extra, 100 m long CAN-ONE sections were picked up on November 2, 1995, during a port call in Honiara, Guadalcanal (Fig 17B). The sections were air freighted from the Digicon factory in Houston, Texas, to Honiara to replace the loss or damage of 2.1 km of CAN-ONE and CAN-TWO streamer during EW95-10.

In an ideal situation, the additional sections would bring the total number of channels to 160 of which 156 would be recording. However, when the longer streamer was deployed, problems developed that reduced the number of channels:

• The entire streamer "built" intermittently in a manner suggesting a bad section somewhere in the tow leader, passive section, or active section near the ship. After suspect sections were removed in these locations, 32 active sections remained that included 20 CAN-ONEs and 12 CAN-TWOs that permitted 128 recording channels (Fig. 16).

• The near-trace (128) source-receiver offset was reduced to 20.1 m when the passive section was removed (Fig. 16). The source-receiver offset for the far trace (channel 1) was 3195.1 m. Four active 100 m sections at the end of the streamer did not build and were towed passively because of the time required to bring in the streamer to remove them. Bad channels determined from shot gathers in this configuration included channels 128, 117, 104, 78, 73, 10, 9 and 5 (see Figure 16 and Table 8 for listing of specs for the Phase 2 streamer)

In addition to the extra streamer sections, additional birds and extra lithium batteries were obtained in Honiara. The additional birds allowed a total of 19 birds to be attached to the Phase 3 streamer, which provided increased lift through the water and resulted in improved depth control (Fig. 16).

Phase 3 Parameters (Lines 32-37)

After line 31, the streamer system crashed and a suspect, active section was removed to leave a total of 31 sections consisting of 11 CAN-TWOs and 20 CAN-ONEs (Fig. 17C). The phase 3 streamer produced five lines at 124 data channels (Fig. 16). The four passive sections continued to be towed at the end of the streamer as during Phase 2.

Phase 4 Parameters (Line 37f-43)

During Line 37, the streamer system crashed and three suspect CAN-TWO sections were removed. The Phase 4 streamer built for 20 minutes out to the farthest section (including the 4 long passive sections at the tail) for a total of 32 active sections (Fig. 17D). After the next crash this shortlived configuration would not rebuild the final four sections. The longer lived, stable Phase 4 streamer had 28 active sections consisting of 8 CAN-TWOs and 20 CAN-ONEs for a total of 112 data channels (Fig. 16).

Non-data Channels: OBAD and passive section

A critical component of the streamer system is the OBAD, or OnBoard Analog to Digital converter, which is located in the science lab. OBAD is used to record sonobuoy data and convert these data into digital form. It was not used on this MCS cruise but it is recorded as if it were four channels in the streamer.

The tow leader is also treated as a passive section and provides 4 more non-data channels. Both the OBAD and the tow leader must be built into the streamer as sections because of their inboard position.

In the Phase 1 of EW95-11, the streamer contained the OBAD, the tow leader and a 100 m passive section (Fig. 16). Ideally, this configuration would produce 12 non-data channels. However, plots of shot gathers showed only 4 empty channels. For Phase 2, the streamer contained the OBAD and the tow leader. Shot gathers during Phase 2 revealed the expected number of 8 non-data channels.

DATE 11/5/95 CHANNELS:	140					CRUISE: GROUP:	EW9511 25M		
SECTION NUMBER	CHAN #	CAN SERIAL #	SECTION SERIAL#	LENGTH	CURRENT DRAW	COMPASS SERIAL#	BIRD #	BIRD SERIAL#	COMMENTS
TAIL ROPE	-	-	4429	50	.6 AND .56 AMPS				
1	1-4	3255	1455	100	.56 AND .51 AMPS				New- installed 10/19/95
2	5-8	1457	1523	100	.55 AND .50 AMPS				
3	9-12	1141	1334	100	.54 AND .50 AMPS		3	9982	
4	13-16	3278	1246	100	.53 AND .48 AMPS				
5	17-20	1254	1176	100	.52 AND .47 AMPS		4	9948	
6	21-24	803	1244	100	.51 AND .46 AMPS				
7	25-28	3114	1460	100	.50 AND .45 AMPS		5	9910	
8	29-32	1345	9466	100					
9	33-36	1248	9450	100			6	9904	
10	37-40	1449	9409	100			*		
11	41-44	3280	9456	100			7	10065	
12	45-48	1239	9442	100					
13	49-52	3046	9453	100			8	10043	
14	53-56	1046	9140	100					
15	57-60	3047	9318	100			9	9969	
16	61-64	3074	9451	100			*		
17	65-68	3265	9376	100			10	9988	
18	69-72	1276	9407	100					
19	73-76	3179	9335	100	.39 AND .34 AMPS		11	10020	
20	77-80	3150	9109	100	.38 AND .33 AMPS				
Conveter	-	-	-	3	.369 AND .32 AMPS		12	10026	
21	81-84	8233	2021	100	CANTO		*		Start Canto Sections
22	85-88	8250	2046	100	CANTO				
23	89-92	8236	2035	100	CANTO		13	10004	
24	93-96	8456	2024	100	CANTO				
25	97-100	8400	2025	100	CANTO		14	9990	
26	101-104	8229	2015	100	CANTO				
27	105-108	8225	2043	100	CANTO		15	9971	
28	109-112	8204	2004	100	CANTO		*		
29	113-116	8405	2039	100	CANTO		16 *	9983	

Table 8. Specifications of Phase 2 streamer. This configuration was used to collect MCS lines 20-30. The larger number of birds on the Phase 2 streamer resulted in the end of the streamer riding at a higher and more favorable depth than the Phase 1 streamer.

SECTION NUMBER		CAN SERIAL #	SECTION SERIAL#	LENGTH	COMPASS NO/BIAS	COMPASS SERIAL#	BIRD NUMBER	BIRD SERIAL#	COMMENTS
30	117-120	8232	2029	100	CANTO		17	9901	
31	121-124	8450	2026	100	CANTO				
32	125-128	8411	2027	100	CANTO		18	9967	
33	129-132	8318	0	47.2	TOW LDR				
34	133-136	8370	0	IN LAB	OBAD				
ARMORED TOW LEADER				47.2					
TOTAL LENGTH				4000.2					

Table 8. Specifications of the Phase 2 streamer (continued from previous page).

Table 9: EW95-11 MCS Line Log

Phase 1 (Times and locations from navigation files)

SOL 1(Reels # 1-2,19-174) 158 reels
578.414 km

292 05:52:16z	06° 38.9623S	161° 43.5999E	Shot 1	File
295 02:26:17z	10° 20.6236S	158° 03.4386E	Shot 12325	File

SOL 2(Reels # 176-235) 60 reels
234.109 km

295 03:41:07z	10° 22.5011S	158° 08.3931E	Shot 2	File 1
296 05:42:32z	10° 52.5997S	160° 07.7747E	Shot 4683	File 4673

SOL3a(Reels # 236-262) 27 reels
108.821 km

296 05:46:00z	10° 52.4501S	160° 08.0242E	Shot 4692	File 1?
296 17:06:48z	10° 09.7680S	160° 48.6282E	Shot 6733	File 2038?

SOL3b(Reels # 263-317) 54 reels
216.805 km

296 17:12:05z	10° 09.5522S	160° 48.9776E	Shot 2	File ?
297 17:21:19z	09° 23.9403S	162° 37.8534E	Shot 4314	File ?

SOL4e(Reels #318-325) 8 reels
28.7051 km

297 17:30:43z	09° 23.2595S	162° 37.6531E	Shot 1	File 1?
297 20:47:07z	09° 09.5896S	162° 33.0583E	Shot 588	File 557?

SOL 5a(Reels # 326-356) 31 reels
115.528 km

297 20:49:33z	09° 09.5698S	162° 32.8713E	Shot 1	File 1?
298 10:05:05z	09° 27.1553S	161° 32.4483E	Shot 2386	File 2381?

SOL 6(Reels # 357-359) 3 reels
10.5873 km

298 10:19:58z	09° 26.4641S	161° 31.8109E	Shot 2	File 1
298 11:26:59z	09° 22.2107S	161° 29.5480E	Shot 203	File 201

SOL 7(Reels # 360-394) 35 reels
141.464 km

298 11:35:34z	09° 21.6480S	161° 29.9435E	Shot 2	File 1
299 02:11:10z	08° 38.8065S	162° 33.1238E	Shot 2627	File 2622

SOL 8(Reels # 395-402) 8 reels
26.194 km

299 02:22:59z	08° 37.9011S	162° 33.0364E	Shot 2	File 1
299 05:12:05z	08° 27.0633S	162° 25.1693E	Shot 509	File 504

SOL 9(Reels # 404-439) 36 reels
139.812 km

299 05:21:50z	08° 27.1142S	162° 24.4802E	Shot 2	File 0
299 20:49:02z	09° 10.7493S	161° 22.9282E	Shot 2771	File 2767

SOL 10(Reels # 440-444) 5 reels
21.75 km

299 21:04:47z	09° 09.9799S	161° 21.9856E	Shot 2	File 1
299 23:21:11z	09° 01.2751S	161° 15.9133E	Shot 411	File 380

SOL 11(Reels # 445-450) 6 reels

299 23:21:42z	09° 01.2492S	161° 15.9462E	Shot 1	File 1
300 02:29:09z	09° 02.3952S	161° 15.2215E	Shot 483	File 391?

SOL 11a(Reels # 451-478) 28 reels
98.9929 km

300 02:29:52z	09° 02.3361S	161° 15.2010E	Shot 1	File 2
300 14:08:21z	08° 24.5653S	161° 55.1696E	Shot 2095	File 2061

SOL 12(Reels # 479-488) 10 reels
39.415 km

300 14:08:55z	08° 24.5282S	161° 55.1387E	Shot 1	File 1
300 18:32:05z	08° 09.2470S	161° 40.2602E	Shot 790	File 765

SOL 13(Reels # 489-513) 25 reels
97.926 km

300 18:32:39z	08° 09.2681S	161° 40.2232E	Shot 1	File 1
301 05:03:06z	08° 42.7569S	160° 58.9583E	Shot 1891	File 1887

SOL 14a(Reels # 514-516) 3 reels

301 08:41:32z	08° 40.7663S	161° 09.6561E	Shot 2	File 1
301 10:01:14z	08° 42.5001S	161° 04.0971E	Shot 241	File 215

SOL 14b(Reels # 517-536) 20 reels
57.8348 km

301 10:01:49z	08° 42.4654S	161° 04.0755E	Shot 1	File 1
301 17:08:27z	08° 14.9495S	160° 49.1908E	Shot 1280	File 1235

SOL 15(Reels # 537-555) 19 reels
67.7221 km

301 17:09:41z	08° 14.9113S	160° 49.2776E	Shot 2	File 1
302 00:48:21z	07° 58.9148S	161° 22.3592E	Shot 1377	File 1346

SOL 16a(Reels # 557-565) 9 reels
32.1254 km

302 00:51:43z	07° 58.6810S	161° 22.2038E	Shot 1	File 1?
302 04:37:31z	07° 43.9502S	161° 13.5269E	Shot 678	File 651?

SOL 17(Reels # 566-596) 31 reels
116.987 km

302 04:38:07z	07° 43.9603S	161° 13.4841E	Shot 1	File 1
302 18:02:37z	08° 12.5136S	160° 16.6848E	Shot 2413	File 2378

SOL 18(Reels # 597-632) 36 reels
139.255 km

302 18:03:10z	08° 12.4676S	160° 16.6739E	Shot 1	File 1
303 09:26:31z	06° 56.0581S	160° 15.3520E	Shot 2769	File 2737

SOL 19(Reels # 633-670) 38 reel
142.945 km

303 09:27:37z	06° 56.0352S	160° 15.2678E	Shot 1	File 1
304 01:54:46z	08° 00.1471S	159° 29.4570E	Shot 2960	File 2956

Phase 2 (Times from line log)

SOL 20(Reels # 672-706) 35 reels
130.523 km

309	0740z	Shot 101	File 1
309	2107z	Shot 2518	File 2416

SOL 21(Reels # 708-718) 11 reels
44.7466 km

309 2142z	Shot 102	File 4
310 0137z	Shot 804	File 705

SOL 22(Reels # 719-747) 29 reels
109.135 km

310 0143z	Shot 100	File 1
310 ~1243z	Shot 2028	File 1980

SOL 23(Reels # 748-764) 17 reels
54.5581 km

310 1258z	Shot 101	File 1
310 1927z	Shot 1269	File 1168

SOL 24(Reels # 765-796) 32 reels
117.046 km

310 2006z	Shot 107	File 100
311 0833z	Shot 2347	File 2339

SOL 25(Reels # 798-808) 11 reels
40.5643 km

311 0845z	Shot 101	File 100
311 1239z	Shot 802	File 800

SOL 26(Reels # 809-840) 32 reels
116.815 km

311 1249z	Shot 101	File 100
312 0107z	Shot 2305	File 2303

SOL 27(Reels # 841-856) 16 reels
53.8234 km

312 0114z	Shot 100	File 100
312 0725z	Shot 1213	File 1213

SOL 28(Reels # 857-894) 38 reels
132.021 km

312 0737z	Shot 101	File 100
312 2233z	Shot 2748	File 2744

SOL 29(Reels # 895-903) 9 reels
34.7151 km

312 2241z	Shot 100	File 100
313 0206z	Shot 714	File 714

SOL 29b(Reels # 904-912) 9 reels
32.4572 km

313 0217z	Shot 101	File 100
313 0535z	Shot 688	File 687

SOL 30(Reels # 913-929) 17 reels
65.1525 km

313 0543z	Shot 101	File 100
313 1214z	Shot 1275	File 1273

SOL 31(Reels # 930-933) 4 reels
(streamer failure)

313 1226z	Shot 101	File 100
313 1400z	Shot 356	File 355

Phase 3 (Times from line log)

SOL 32(Reels # 934-954) 21 reels
77.1633 km

313 1815z	Shot 100	File 100
314 0223z	Shot 1562	File 1559

SOL 33(Reels # 955-986) 32 reels
112.659 km

314 0459z	Shot 100	File 100
314 1752z	Shot 2399	File 2395

SOL 34(Reels # 987-1003) 17 reels
56.8831 km

314 1801z	Shot 101	File 100
315 0003z	Shot 1182	File 1180

SOL 35(Reels # 1004-1016) 13 reels
44.0474 km

315 0011z	Shot 102	File 101
315 0452z	Shot 947	File 946

SOL 36(Reels # 1017-1020) 4 reels
(transit back to waypoint)

315 0604z	Shot 101	File 100
315 0738z	Shot 383	File 382

SOL 37b(Reels # 1021-1025) 5 reels
b,y,f = 46.3274 km

315 0803z	Shot 101	File 100
315 ~0947z	Shot 415	File 393

SOL 37c(Reels # 1026-1027) >1 reels

315 1158z	Shot 101	File 100
315 1255z	Shot 275	File 217

SOL 37d(Reels # 1027) 1 reel

315 1623z	Shot 101	File 100
315 1634z	Shot 131	File 137

Phase 4 (Times from line log)

SOL 37f(Reels # 1028-1032) 5 reels

315 1907z	Shot 101	File 100
315 ~2101z	Shot 444	File 422

SOL 38(Reels # 1033-1042) 10 reels
35.1693 km

315 2125z	Shot 101	File 100
316 0133z	Shot 847	File 845

SOL 39(Reels # 1043-1051) 9 reels
28.951 km

316 0145z	Shot 101	File 100
316 0446z	Shot 647	File 646

SOL 40(Reels # 1052-1061) 10 reels
30.912 km

316 0524z	Shot 101	File 100
316 0853z	Shot 743	File 742

SOL 41(Reels # 1062-1075) 14 reels
50.5247 km

316 0912z	Shot 101	File 100
316 1459z	Shot 1145	File 1142

SOL 42(Reels # 1076-1082) 7 reels
24.3136 km

316 1515z	Shot 101	File 100
316 1745z	Shot 553	File 552

SOL 43(Reels # 1083-1136) 54 reels
196.381 km

316 1803z	Shot 101	File 100
317 1639z	Shot 4169	File 4167

Summary of MCS Data Gaps

There were six significant data gaps in the EW9511 MCS survey caused by:
- failure of the air compressors to the airguns
- the recording system
- or the streamer.

Streamer failure was the most serious of these three problems and produced the longest lasting data gaps that resulted in the division of streamer phases 1-4 (Fig. 16).

The first data gap on Line 3b and lasting for 9 minutes was related to a compressor problem. The second gap occurred on Line 11, lasted for 27 minutes and was related to a system crash. The third data gap occurred during Line 23, lasted for 24 minutes, and was related to a recording system crash. The fourth data gap was a streamer failure during Line 31. The fifth data gap was an 8-minute system crash during Line 33. The final data gap occurred on Line 43 for 5 minutes and was related to a compressor problem.

The guns stopped briefly on JD 297 from 0300-0301z due to a compressor problem during Phase 1. After Line 19, the streamer was brought onboard for the transit back to Honiara and the extra sections obtained in Honiara were added onto the streamer.

After numerous tests and crashes, the Phase 2 streamer was deployed for Lines 20-31. A system crash occurred between Lines 23 and 24. A second system crash occurred during Line 28, on JD 312 from 1658-1712z and the streamer failed again during Line 31. Since this was a transit line, the ship stayed on the line while the streamer was repaired.

The Phase 3 streamer was deployed for the start of Line 32. A system crash occurred during Line 33, on JD 314 from 1700-1708z. The system crashed again at the end of Line 35. The ship headed down the next line while the streamer was repaired. When the streamer was redeployed, the ship turned back to the original waypoint and shot Line 36 from south to north. Line 37b began at the waypoint. The system crashed again after about 12 km of shooting. Line 37d lasted about 30 minutes before the system failed again. More streamer work followed. Finally, the Phase 4 streamer was deployed for Lines 37f-43. During Line 43, the air guns were shut down for 5 minutes on JD 317 from 0415-0420z due to a compressor problem.

Below are listed the data gaps observed on the brute stack plots of the MCS lines. If the gap was noted in the logs, the corresponding error message is included. Explanations are provided for the lines with letter designations.

<u>SOL 1</u>
294 ~0820 gap not noted in logs

<u>SOL 3a</u> (problem starting line)

<u>SOL 3b</u> (change in line direction)
297 1039-1048 air guns offline (air pressure problem)
297 ~1200 gap not noted in logs

<u>SOL 4e</u> (problems starting line)
298 ~0510 gap not noted in logs

<u>SOL 6</u>
plot looks strange at end of line, gun #17 offline, nothing else noted in logs

<u>SOL 11</u>
299 2358 - 300 0025 system crash
300 0039 turning around to restart line, continue shooting

<u>SOL 11a</u> (system crash)
300 0657 gap "tape unit 2 not at BOT", looks like Peter's problem

<u>SOL 13</u>
300 2132 gap "tape unit 2 not at BOT", looks like Peter's problem

<u>SOL 14a,b</u> (extra turn close in to Malaita)

<u>SOL 15</u>
301 ~2135 gap not noted in logs

<u>SOL 21</u>
310 ~0000 gap "data not received"

SOL 22

310 ~0645 gap "tape unit 2 not at BOT", looks like Peter's problem

SOL 23

310 1940-2004 system crash

SOL 26

311 ~2145 gap "SLIC data not received"
312 ~0333 gap "SLIC data not received"
312 ~0517 gap "SLIC data not received"

SOL 28

312 0826 gap "SLIC data not received"
312 0950 gap "file may be bad, tape unit 2 not at BOT"
312 ~1140 gap not noted
312 ~1330 gap not noted
312 1612 "SLIC data not received"
312 1658-1712 system crash

SOL 29,29b (change in line direction)

313 0337 gap "SLIC data not received"

SOL 31

brought in streamer for repair - transit line

SOL 32

numerous "problems with Peter's program"

SOL 33

314 0942 "SLIC data not received"
314 1700-1708 system crash
315 ~0246 "file may be bad"

SOL 37c,d,f (system and streamer problems)

plot has problems

SOL 43

317 0150 "SLIC data not received"
317 0415-0420 air guns offline (compressor problem)

MCS recording system

The DSS-240 system is a distributed network of processors making up a number of subsystems responsible for different aspects of the seismic data recording (Fig. 18). The following paragraphs will attempt to explain the recording process from the initiation of a shot cycle to the writing of the seismic data to tape.

The shot cycle originates in the Radio Data Link 3 (RDL3), a multi-boat system controller that can regulate up to three seismic vessels (Fig. 19). If the survey required that shots occur at a specified distance, then the shot cycle begins when the ship's navigation system, SPECTRA, sends the Nav Clock signal to the RDL3 when the specified distance is traversed. Since we were firing by time and not distance, the RDL3 kept track of the time interval plus randomization and the Radio Event Synchronization System 2 (REVS2) within RDL3 initiated the shot cycle by sending the Nav Clock Prime (NCP) closure through the System Interface Board (SIB) to the Serial Line Interface Controller (SLIC). This occured exactly 312 ms after REVS2 received closure from RDL3. The SLIC monitors asynchronous serial devices such as the air pressure monitor and streamer cable tensionand returns this information to RDL3.

When it receives the NCP, the SIB also passes it on to the Timing Analysis for Gun Synchronization (TAGS) engine (Fig. 20). TAGS controls the firing of the airgun array as well as logging quality control information for every shot. Upon receiving the NCP, TAGS provides RDL3 with its setup (a constant for our single airgun array) and the source enable status. TAGS also gives source and array information to the Closed Loop Automatic Source Synchronizer (CLASS) about which guns to fire and at what time. Since each gun has its firing line and shuttle motion detector connected through a single channel to CLASS, CLASS is responsible for firing the guns at precisely the right time.

When RDL3 receives the source enable status from TAGS, it decides whether the guns may be fired. If all the conditions are met for shooting, REVS2 gives the BLAST command to the CLASS. Once the guns have fired, the CLASS generates a Time Break closure and sends it to the SIB. It also sends the measured firing times to TAGS which calculates the early/late or no-fires. TAGS system reporting sends this data to three places: a monitor displaying the gun status; the Control Executive Overseer (CEO) where a line of print showing the gun status is logged; and to the Ethernet Line Interface Controller (ELIC) which directs the information to the Cable Supervisor and Recording Unit (CSRU) so the data can be recorded on tape. The CEO is a graphical user interface used to program the CSRU.

When the SIB receives a Time Break closure, it generates a Time Break Echo (TBE) which is then sent to RDL3. If RDL3 does not receive the TBE within a specific time window after receiving the Nav Clock, then the data from that particular shot is not recorded and an error is reported. After sending the NCP, RDL3 receives the shot number, GPS recorded shot time, and ship position from SPECTRA. If the TBE is received on time, this information is sent through the ELIC to the CSRU to be recorded in Trace0 on the 3480 tape along with the gun status for that particular shot.

Once the seismic data is digitized and sent to the Cable Subsystems (CSS) from the telemetry cans, it is transferred through the Hydrophone Array Sampling and Telemetry Electronics (HASTE) Personality module to the GPCC interface board where it is demultiplexed (Fig. 21). From the GPCC, the data gets transferred by a VME bus to the PC Cable Data Display (PCDD) memory buffers. The VME bus is a high performance 32 bit bus with a data throughput bandwidth of 10 megabits/second. This high transfer rate is required for the large volume of seismic data being passed from the streamers to the buffers for every shot. When the demultiplexing is complete, a signal is sent to the PCDD to begin displaying the most recent seismic data. The data is displayed at a sample rate of 125 Hz without application of an anti-aliasing filter so aliasing is inevitable. The PCDD has 16 megabytes of memory broken into three buffers. Two six megabyte buffers are used by the CSRU to stage the seismic data. At the same time the PCDD is displaying the data, a SCSI Splitter is copying the data from the VME side of the memory and recording it in SEG D format on the 3480 tapes. This is occuring at the same time the non-seismic data is entering the CSRU through a smaller GPIB bus (0.1 Mbit/sec data throughput). This non-seismic data was the above mentioned data sent to the CSRU from the SLIC, ELIC, and CEO. Another copy of the seismic data is used for a real time brute stack display and near trace display on two flatbed plotters.

Brute stack plots

A LDEO program written by Peter Buhl called "splitter" reads the MCS data from the Cable Data Display shared memory unit and makes a real-time brute stack. The stack is plotted on a flatbed plotter in the main science lab. There are numerous gaps in these plots that do not represent data gaps, but problems with the splitter program ("Peter's program"). A problem with the inside mute in the program was easily fixed once the problem was identified. There are also gaps at the beginning and end of each line, where the program did not have enough data for the stack.

There are four rolls of splitter plots being returned to UTIG. The vertical scale (time axis) remained constant throughout the survey while the horizontal scale varied. During Lines 24-27, the horizontal scale changed numerous times due to a system error. Only an approximate vertical exaggeration was calculated, due to the fact that the vertical axis has units of time and the horizontal axis has units of distance. The time axis was converted to depth using a velocity of 1750 m/s.

Roll #1 Lines 1-13
Roll #2 Lines 14-23
Roll #3 Lines 24-37b

Roll #4 Lines 37c,d,f-43

Vertical scale:

1 second = 2.453 in (constant throughout survey)

Horizontal scale: (VE calculated roughly using 1750 m/s for depth conversion)

Lines 1-23 1 km = 0.382 in (VE 7:1)
Line 24: 1 km = 0.259 in (11:1) to 0.170 in (17:1) to 0.146 in (19:1)
Line 26: 1 km = 0.146 in (19:1) to 0.167 in (17:1) to 0.146 in (19:1)
Line 27: 1 km = 0.135 in (21:1) to 0.007 in (400:1)
Line 28: 1 km = 0.128 in (22:1)
Line 32: 1 km = 0.368 in (8:1)
Line 33: 1 km = 0.347 in (8:1) to 0.326 in (9:1) to 0.274 in (10:1)
Line 38: 1 km = 0.358 in (8:1)
Line 39: 1 km = 0.198 in (14:1)
Line 40: 1 km = 0.215 in (13:1)

There is also a roll of the near trace plot called profiler A. The following plots are being returned to UTIG along with the splitter plots also listed:

Seismic profiler A roll 1	Lines 1-13
Seismic profiler A roll 2	Lines 14-23
Seismic profiler A roll 3	Lines 24-37b
Seismic profiler A roll 4	Lines 37c,d,f-43

Splitter brute stack roll 1	Lines 1-13
Splitter brute stack roll 2	Lines 14-23
Splitter brute stack roll 3	Lines 24-37b
Splitter brute stack roll 4	Lines 37c,d,f-43

ONBOARD DATA PROCESSING BY E. PHINNEY AND A. TEAGAN

Introduction

MCS data from EW95-11 are recorded on approximately 1200 3480 cartridge tapes in SEG D format. The data are sampled at 2 milliseconds with a total record length of 16 seconds.

The EW9511 survey can be divided into four phases, based on the condition of the streamer. Phase 1 consists of Lines 1-19, during which the streamer contained 32 active sections (116 data channels). After Line 19, the ship returned to port to pick up eleven additional streamer sections. Due to a number of problems, there was a net gain of only three sections. Phase 2 consisted of Lines 20-31. The streamer contained 32 active sections (128 data channels). Another bad section was removed after Line 31. Phase 3 includes Lines 32-37 with a streamer containing 31 active sections (124 data channels). Phase 4 includes Lines 37-43 with a streamer containing 28 active sections (112 data channels) (Fig. 16).

The sound source is an 8505 cubic inch array of 20 air guns deployed from a gun boom off the back deck of the ship. The guns are set to fire every 20 seconds, which corresponds to a 50 meter shot spacing at a speed of 4.5-5 knots.

The shipboard processing was performed on Phase 1 lines only (Figure 17A). SIOSEIS is the processing software used onboard.

Quality Control

During each line, shot gathers were plotted to check the data from each channel (Fig. 22). For Lines 1-19, the known bad traces are 116, 115, 87, 85, 80, 55, 50 and 3. These traces are zeroed before the data are sorted into RPs and stacked.

Traces 116 and 115 are the near traces and as such are expected to be somewhat noisy. However, the near-trace noise in this case does not appear to be significant. The amplifier for channel 115 appeared to be malfunctioning.

Channel 3 is located near the tail end of the streamer which tended to dive sporadically; therefore, the noise on trace 3 may be caused by the extra motion of the birds required to position the streamer at its target depth.

Channels 80 and 50 are dead traces; they did not record any data at all. Channels 87, 85, and 55 were weighted to zero due to their susceptance to random noise spikes.

Processing

The first step in the processing sequence is to extract the SEG D data from the 3480 tapes. SIOSEIS reads the 3480 tapes and converts the data to SEG Y format. The SEG Y data is then copied to disk files or processed directly from tape. Disk space is limited on the ship, so the larger lines were processed directly from tape. A band pass filter of 10 to 62 Hz is applied to the data as it is extracted from tape.

Next, a velocity analysis is performed at several points along the line (Fig. 23A, B). Semblance spectra were used to indicate the best velocity. In some cases, the SIOSEIS velocity analysis provides distinct velocity peaks at times that correspond to seismic reflectors. These velocity values are then used in the normal moveout (NMO) of the data (Fig. 24). In other cases, the velocity analysis does not show any semblance peaks. The stacking velocity field must be constructed based on lithology inferred from single-trace plots.

The water depths in the Phase 1 area are generally between 2 and 3 seconds. Therefore, the water bottom multiple is a problem. An inside mute was performed on the data before stack in an attempt to weaken the multiple. This consists of examining a moved-out RP gathers (Fig. 25). The water bottom mulitple is horizontal on the near traces, which will cause it to add coherently during stack, so this section of the near traces is zeroed. The inside mute was generally applied to between 40 and 50 traces. A second type of mute was applied to the far-offset traces. This mute is designed to reduce the noise associated with the end of the streamer and eliminate wavelet stretching resulting from NMO (Fig. 25). A band pass filter of 10 to 40 Hz is applied to the data after the mutes. A time-varying band pass filter can be used to further weaken the seafloor multiple because the multiple is at higher frequencies.

The data are then stacked and muted down to the seafloor. An FK migration is performed using the water velocity obtained from the velocity analysis. This improves the image close to the seafloor, but significantly overmigrates the multiple, producing upside-down diffraction hyperbolas (smiles).

Line 1 was processed in its entirety. This is the longest line in the survey. It begins northeast of the Solomon Islands over the Ontong Java Plateau. It crosses the Roncador Homocline, the North Solomon Trench, the Malaita Anticlinorium, and continues its southwest trend over the San Crisobal Trench to the Louisiade Plateau. The section of Line 3b that crosses the Indispensable Basin was processed for comparison with the Line 1 crossing of the basin (see Geologic Problems).

Wavelet Analysis--Effects of airgun misfiring during EW95-11 by E. Phinney

A brief investigation into the effects of airgun misfiring on the source wavelet was conducted to help in the design of a deconvolution operator for removal of the bubble pulse. The study was performed on shot numbers 3263-3284 (GMT 293 0003 to 293 0010, Figure xx, section xx) along Line 1 over the southwest dipping slope of the Ontong Java Plateau. The lack of complex structure in this area allows the sea floor reflection to be a reasonable approximation of the source wavelet. Channel 114 (offset 170.1 m) from each shot was used in the analysis to eliminate any changes in waveform due to offset. The section of streamer containing channel 114 was at a constant depth over the course of the twenty-two shots.

Gun 17 (displacement of 260 in^3) fired outside the specified tolerance range (out-of-spec) governed by the Timing Analysis for Gun Synchronization system on shot numbers 3263-3271 and 3273 (Figure 26). A total volume of 1110 in^3 fired out-of-spec for shot 3272. The out-of-spec volume included gun 17 plus an unknown number of other guns. The exact values of the misfiring times for the above shots were not known at the time of this report. The wavelets from the above shots were compared with the wavelets from shots 3274-3284 where all guns fired within the tolerance range (in-spec).

The traces from shots 3262-3271 and 3273 were flattened on their water bottom reflection peaks and averaged into a single trace (Figures 27 and 29). The same process was followed for the traces from shots 3274-3284 (Figures 28 and 30). The trace from shot 3272 is shown in Figure 31. Peak to bubble ratios were calculated between the water bottom reflection peak and three trailing bubble pulses for the traces in Figure 29 through Figure 31. The average bubble frequency was also measured for each trace. The power spectrums from the original data traces were grouped and averaged in the same fashion as above (Figures 32-34). Cumulative energy versus frequency was also calculated from each of the power spectrums for comparison (Figure 35).

Comparison of the power spectra revealed no significant information. The spectrum for the in-spec traces had a slightly larger peak centered at 30 Hz (Figure 33). The spectrum for shot 3272 appeared to have larger peaks at all frequencies than the other two spectra; however, the others were averaged spectra and had consequently been smoothed. The cumulative energy versus frequency curves revealed that the energy plateaus at a higher level when the guns were firing out-of-spec (Figure 35). The cumulative energy consistently plateaus around 100 Hz for all three cases.

The peak to bubble ratios for the three bubble pulses when all the guns were firing in-spec were 10.8, 8.6, and 12.1. The ratios when gun 17 was firing out-of-spec were 7.8, 6.0 and 6.0. The ratios became even smaller when the 1110 in^3 volume fired out-of-spec: 4.2, 5.2, and 3.3. The average bubble pulse frequency decreased from 48.4 Hz when all the guns fired on time to 46.9 Hz when gun 17 fired out-of-spec. The frequency decreased to 45.4 Hz with the increase to 1110 in^3 of the total volume firing out-of-spec. Inspection of the original traces before averaging shows that they are noisier when all the guns are firing in-spec than when gun 17 is firing out-of-spec (Figure 27 and 28). The extra noise may effectively decrease the peak to bubble ratios for the averaged in-spec traces due to a larger degree of smoothing. Consequently, the effect that the guns firing out-of-spec has on the peak to bubble ratio may be greater than is numerically shown here.

PROCESSING PLAN AT UTIG FOR MCS DATA BY T. SHIPLEY

Ewing 9511 lines cross complicated structure and varying seafloor depths requiring extensive processing. The procedures will vary as a function of water depth and geologic structure. The primary problems are:

- water bottom multiple suppression, an iterative and local area dependent problem;
- structural dips requiring proper pre-stack reflector placement with partial DMO.

Both the multiple and dip problems necessitate well-determined velocity functions. Basic spiking deconvolution has been shown to significantly improve the source function.

Another major problem is the volume of data. The Ewing 9511 recorded 80,000 shots, about 300 GB on 1113 tapes (approximately 4000 km of lines).

Step 1: SEG-D to SEG-Y conversion and backup copy

Jan 96 through Aug. 96
Undergraduate TBA
On workstations with Sioseis

We will use Sioseis to read SEG-D, anti-alias filter, resample, limit data to 12 s and output SEG-Y (depending on cable geometry, either 114,124,120 or 108 traces) to Exabyte or

Digital Linear Tape. The tape output will be organized as a single line to (usually) a single Exabyte tape. This process will also put the Lamont shot number and navigation time into the headers providing a direct link between navigation in the ts.nav files to the seismic data.

Also output will be a near trace to separate disk file. The near trace data will be FK-migrated, filtered, amplitude scaled, and loaded into our interpretation system with navigation. These data will be used to help determine processing priority and provide a first look at the data. These files will be scanned for missing shots, bad shots and header information problems.

This processing step will turn about 375 GB into about 140 GB after decimation, and reducing the trace length to 12 s.

Step 2: Line 1 Processing

Jan 96 through June 96
Eric Phinney & Data Processor TBA (3-m)
Workstations (Arc 20-712; Wedge 20-612; Seismic 20-71) and Cray as appropriate
Geovecteur software.

We will use workstations for processing, but if it proves too slow we will move to the Cray. Not all parts of line 1 will necessarily be fully processed, but improved brute stacks will be the minimum.

Line 1 (~15 % of the total shots)
- Line 1a OJP (292/0552 to 293/0100) ~3400 shots
- Line 1b North Solomon Trench (293/0100 to 293/1610) ~2700 shots
- Line 1c Florida Platform (293/1610 to 294/0600) ~2500 shots
- Line 1d San Cristobal Tr./Louisiade Plateau (294/0600 to 295/0226) ~3700 shots

Step 3: Data Set Processing

June 96 through December 97
Eric Phinney & Undergraduate ("full time"), plus Data Processor (?-m)
Reassess processing program. Brute stacks of remaining lines; and
- either pick parts of lines for special processing,
- or pick specific lines for further work,
- or continue to fully process one line at a time

PROJECT OBJECTIVES FOR MCS DATA BY P. MANN, M. COFFIN, AND T. SHIPLEY

Fate of oceanic plateaus at subduction zones: North Solomon trench and Malaita anticlinorium

The top priority of the MCS-OBS components of this proposal is to address the problem of whether oceanic plateaus are subducted or accreted to island arcs. We addressed this problem during EW95-11 by collecting about 4000 km of MCS data and a 500 km long OBS transect across the North Solomon trench and the Malaita anticlinorium (Fig. 10). There were two advantages of a marine geophysical study of the Solomon Islands over land-based studies of the edges of proposed ancient plateaus:

1. The convergent zone between the Ontong Java Plateau and Solomon island arc is a primordial, mostly submerged mountain belt that is relatively free of tectonic overprinting during subsequent tectonic phases.

2. The shallow (0-5 km) marine structures and stratigraphy of the Ontong Java Plateau and Solomon island arc have been well mapped by a systematic regional study by DSDP (Legs 7, 30, 89), ODP (Leg 130), Kroenke in the 1960's and 1970's using sparker profiles, the U. S. Geological Survey in the 1980's (Fig. 4) and by onland mapping by geologists from the Ministry of Energy, Water and Mineral Resources of the Solomon Islands. These previous onland and marine data are not sufficient to distinguish between two different models for the structural relationship between the Ontong Java Plateau and the Solomon Island arc. Resolution of these controversies are necessary before using the Solomon-Ontong Java Plateau puzzle as a key or

template for explaining the role of oceanic plateaus in the growth of continental lithosphere through time.

Testable models for juxtaposition of the Ontong Java Plateau and the Solomon island arc. Previous earthquake, onland mapping, and marine geophysical data suggest that the collision produced the Malaita anticlinorium, cessation of southwestward subduction at the North Solomon trench, and initiation of northeastward subduction at the San Cristobal trench. Intermediate to deep earthquakes define the top of the subducted Pacific plate as a continuous feature to depths of 200 km beneath the Solomon Islands while shallow to intermediate depth earthquakes suggest the initiation of subduction of the India-Australia plate in a diffuse zone along the southern edge of the arc. Previous studies and available data suggest two models to us for the juxtaposition of the Ontong Java Plateau and the Solomon island arc:

Model 1: Malaita anticlinorium obducted by tectonic wedging (i. e. a triangular wedge of the Solomon island arc has delaminated a crustal "flake" of the Ontong Java Plateau). Work in ancient onland mountain belts has led to the idea by several previous workers that when two plates collide it is possible for large, sheet-like masses of material ("flakes") to be sheared from the top of one of them and driven over the other for distances of more than 100 km. One block acts as a triangular wedge that splits the other block into a thin upper flake that overrides it and a thick lower slab that dips beneath it. This process that has recently become known as "tectonic wedging" is better documented from mainly industry onland seismic profiles across the mountain fronts of fold-thrust belts . This process is commonly associated with thrusting towards a thick continental or heavily sedimented block. A diagnostic characteristic of wedging are unfaulted monoclines dipping towards the foreland.

Northeastward dips on the Malaita anticlinorium suggests the idea that the underlying area is an upper crustal flake of the Ontong Java Plateau that has been peeled back and tilted to the northeast. Earthquake studies by Cooper et al. (1986) indicate the presence of a decollement beneath the Malaita anticlinorium that dips northward from a depth of 20-25 km near the Florida Group to a depth of 40-45 km north of Malaita Island. The depth of 40-45 km is close to previous estimates for the crustal thickness of the Ontong Java Plateau and may suggest that the entire crust of the Ontong Java Plateau was delaminated to form the Malaita anticlinorium and that the underlying lithosphere has descended along the relict Benioff zone.

MCS objectives to test Model 1: The MCS-OBS transects will determine whether the Malaita anticlinorium rests on a northeastward back or roof thrust. If such a detachment is present at depth, one would expect to image northeast-dipping layering and/or northeast-verging structures at depth. Monitor records of MCS data collected on EW95-11 indicate complex processing will be required to remove effects of steep topography, complex faulting and folding and the bottom water multiple.

Model 2: Malaita anticlinorium formed as a northeast-verging accretionary wedge of pelagic and igneous rocks offscraped during shallow subduction of the Ontong Java plateau. Because of their greater crustal thickness, most oceanic plateaus stand more than 2 km higher than the surrounding seafloor. With an average water depth of about 2000 m the Ontong Java Plateau stands about 3 km higher above the surrounding "typical" Jurassic-Cretaceous ocean floor. It seems reasonable that Malaita anticlinorium, that forms a 100-150 km wide, arcuate protuberance on the otherwise linear Solomon island arc, was produced by the accretion of Ontong Java sedimentary and igneous rocks to a northeast-facing arc. Although the Pacific-Solomon island arc convergence angle is thought to be oblique (~060°) in the late Cenozoic, the presence of a well defined, 200 km long Benioff zone aligned with the North Solomon trench suggests a significant degree of underthrusting over the last 10 m.y.

Survey objectives to test Model 2: The MCS-OBS transects will determine whether the Malaita anticlinorium is made up of imbricate slices of sedimentary and igneous material of similar velocity and character to that of the Ontong Java Plateau. Kroenke (1972) identified northeastward-verging reverse faults and folds of the Malaita anticlinorium that supports the idea of an accretionary wedge origin.

Deeper penetration MCS data will better constrain the dip and character of faults at depth. If the accretionary prism model is correct, we would expect to see imbricate reverse and thrust faults that sole on a basal detachment fault. Such faults would produce a much higher degree of lithologic diversity than predicted by the tectonic wedge model, where the obducted crustal wedge may be a coherent piece of plateau crust detached along a single fault. The Japanese OBS data will be particularly useful for distinguishing abrupt contrasts between basaltic, limestone, and chert lithologies and also for mapping structural faults and folds within these sequences. We would also like to combine the MCS data with interpretation of shipboard gravity and magnetic data in order to map slivers of igneous or ultramafic material in the wedge (see section on gravity below).

Subduction initiation: San Cristobal trench and forearc

Testable models for initiation of subduction following arc polarity reversal. A secondary objective of our study is to test two models for the deformational pattern that can result in the initiation of the San Cristobal subduction zone along the southwestern margin of the Solomon island arc. It should be noted that these models may not be contradictory but rather form two evolutionary stages in the subduction process. MCS and OBS profiles proposed in this study will provide constaints on the structure of the upper 10-15 km of crust, a tectonically important "gray zone" sandwiched between an upper crust well studied by geologic mapping and 24 channel MCS data and the slab geometry in the upper mantle known from the hypocenters of intermediate to deep earthquakes.

Model 1: Diffuse thrusting of the overriding plate as a precursor to subduction. Silver et al. (1983) and Silver et al. (1986) proposed that subduction could initiate in thermally weakened crust of the back arc as a direct response to the transmission of stresses through the arc. As collision proceeds, the horizontal stress across the arc increases and arc volcanism is retarded. The San Cristobal trench may have passed through the subduction stage represented by Model 1 during late-early to early-late Miocene, the age of a widespread hiatus in the ages of arc volcanism in the Solomon Islands.

Survey objective for Model 1: If the diffuse thrusting model continues to be active along the San Cristobal trench, one would expect to see displacement on several thrust faults rather than motion concentrated on a single decollement. Unlike much of the Indonesian arc, navigable passages through the Solomon Islands will allow us to collect deep penetration seismic lines that span the entire forearc zone of diffuse seismicity.

Model 2: Subduction initiation. Subduction initiation would be characterized by the presence of a continous downgoing plate. The presence of intermediate depth seismicity to about 80 km suggests that self-sustaining subduction may have been initiated along the San Cristobal trench. Using 24 fold data, Bruns et al. (1986) were able to follow a decollement over a horizontal distance of about 30 km.

Survey objectives for Model 2. We propose to image the top of the downgoing plate in an attempt to see whether subduction has been initiated along a single decollement. Does this feature cross cut older fault surfaces producted during the earlier stages of subduction initiation?

HYDROSWEEP BY S. COWLEY

Data type

The R/V Maurice Ewing uses a hull-mounted Hydrosweep DS formed beam swath mapping sonar. The name ATLAS HYDROSWEEP comes from "HYDROgraphic multi-Beam SWEEPing Survey Echo sounder" and is manufactured by the Krupp Company of Germany. Krupp has discontinued the manufacture of these types of seafloor system and therefore there is no manufacturer's service support for this equipment.

This equipment is used for surveying of areas in both shallow and deep sea regions. Beam width is a function of water depth with the extended range beam being double the water depth with a greater width obtained from a level sea floor. Shallow water surveys are therefore much more time consuming than deeper water surveys. The hydrosweep system has a broad coverage angle of 90 degrees perpendicular to the ships longitudinal axis. With such broad coverage 59 depth values are measured per sounding.

The Hydrosweep produces 59 roll and pitch stabilized formed beams for each ping from its transducers (Fig. 37). At each ping of the Hydrosweep, data, that include cross track distances, travel time, depths and amplitude values, are being broadcast realtime in the network and are received by the data logger (Fig. 37). The logger computer extracts the center beam depth directly beneath the hull of the ship for bathymetric purposes. This data is logged both on half inch computer tape and in the Ewing's logging system simultaneously (Fig. 37). The wider beam, or extended range, is recorded but not displayed unless the science group has contracted for this service that includes some processing costs. Visual checking on the Hydrosweep monitor in the science lab is aided by a graphic editor to remove major spikes in the data. Data gaps are produced during bottom loss detects that generally occur over areas of steep and uneven sea floor.

The data is displayed in real time on a color monitor in the science lab as well as being recorded to tape for future processing if such costs are met by the science party. There is a serial port for transferring on-line measured data to a postprocessing computer system. The data content is a subset of the recorded values on magnetic tape.

Hydrosweep equipment

Equipment of the Hydrosweep system consists of:

•Two hoydroacoustic transducer arrays. These consist of several individual modules and are installed in a T-configuration (Fig. 38).

• The transceiver electronics housed in electronics cabinets in the main science lab (Fig. 37).

• The control/display console showing measured values as a color contour display. Input into the system to change operating parameters is through a keyboard on this console. Adjacent to the color display is a monochrome monitor giving numerical information.

• A magnetic tape drive unit with computer that records the parameters, measured depth values, and position values supplied by connected equipment.

• External signal interfaces facilitate exchange of data between the hydrosweep equipment and the ships navigation system. Other data are transferred on a continuous basis include the ships speed over ground, the roll angle, the pitch angle as well as the heave. All of this is stored on magnetic tape.

The hydrosweep operates using multibeam sweeping echo sounding. The transmitted signal has a frequency of 15.5kHz. The equipment automatically adapts it's transmitting and receiving modes to the water depth to maximize it's performance. It has a shallow water, medium depth and deep sea operating mode for water in the ranges 10-100m, 100-1000m, >1000m respectively. For the first two depth ranges what is referred to as Omni Directional Transmission or ODT is the operational configuration for the transmission array where "omni" means 90°.

For water deeper than 1000m the transmission array operates in Rotational Directional Transmission mode. Transmission occurs in three different directions in three pulses immediately following one another. The advantage of RDT mode is the higher source level.

Stabilization takes place for both pitch and roll during transmission but for roll only on the receiving side. Pitch stabilization is unnecessary because the beam width in the pitch direction is about 22 degrees.

In the receiving mode depth dependent array lengths apply and again the switch over is automatic. This is so that measurement takes place with a beam pattern fully formed at the minimum depth.

Transducer arrays consist of two perpendicular arrays mounted flush with the bottom of the ship (Fig. 38). These arrays have a dual function being able to transmit and receive. Each of the two arrays consist of three identical subarrays consisting of an arrangement of 96 transducers each of which can be driven individually. For receiving the elements of each subarray are connected as rows while for transmitting they are connected column by column. Photographs of the ship in drydock in early 1995 revealed that the array housings protrude significantly from the hull.

Besides the arrays the two other important parts to the system are the transmission electronics and the reception electronics. During transmission each group of four transducers is driven by it's own transmission power stage. The output of the individual transmission stages are shaded with respect to power to produce the required suppression of the side lobes in the transmitted beam. From pitch and roll values a processor computes the necessary delays for the phase driving of the arrays and also specifies which transmitter is to transmit.

After transmission the equipment switches over to the receiving mode and begins evaluation of the echoes. The reception circuitry amplifies the received signal of all 72 transducer rows. The output of these amplifiers is sent to the beamformer in digital form. This computes the 59 direction dependent performed beams (PFB's) allowing for roll angle and the influence of the sound velocity in the water at the transducer surface. This PFB data is filtered (bandwidth 100Hz) and sent to the echo evaluator which computes the slant depth of the individual stabilized PFB's.

For the purposes of the Ewing cruise EW9511 the center beam depth was what we were principally concerned with. This was used in other programs and will be used to draw bathymetric profiles of the sea surface. The support of the hydrosweep system was not included for in the proposal to the NSF when the original project came about.

There are different support levels depending upon how much processing done on board ship by the Ewing science staff. For all cruises the system operates as normal and all data is recorded to magnetic tape. Depending upon whether the hydrosweep was funded for the particular project or not these tapes may be copied or are stored in archives. Various levels of processing are also available. For EW95-11 we will receive final calibrated and cleaned center beam data that is merged with the final navigation and shown in meters. The format of these data are:

hb.nddd
yy+ddd:hh:mm:ss:mmm N 12 12.1234 E 123 12.1234 2222.0
yr. day time lat. lon depth_in_meters

Data were collected during this period of EW95-11.

DAY	TIME	COMMENTS
290	0025	start of cruise, started logging/processing
304	1756	returned to Honiara to pick up more MCS sections ; data logging suspended
305	0003	data logging resumed
305	1415	OBS recovery ; HS was turned off
306	0049	data logging resumed
323	0000	end of cruise; stopped logging/processing

SEA WATER TEMPERATURE

Sea water temperature was logged from the beginning to the end of the cruise at one minute intervals using an Omega DP 10 series thermometer. No checking or smoothing was done to these data. All data that is merged with navigation resides at LDEO. The format is:

ct.nddd
yy+ddd:hh:mm:ss:mmm N 12 12.1234 E 123.1234 26.3
yr day time lat lon sea_temp (in ^{o}C)

These data were logged during the period shown below.

DAY	TIME	COMMENTS

289	2330	start of cruise, started logging/processing
323	0000	end of cruise; stopped logging/processing

3.5 kHz SONAR SYSTEM BY S. MIURA

The 3.5 kHz sonar system is an echo sounder used to obtain bathymetric information as well as subbottom structures in shallow water areas. The sonar system on the Ewing consists of a transceiver, a chart recorder, and a transducer (Fig. 39). The chart recorder triggers the transmitter which sends a tone burst into the water through the transducer. The echoes from the sea bottom and subbottom are picked up by the transducer, amplified by the receiver and displayed on a recorder in the science lab. The rolls recorded and their time intervals during EW95-11 are summarized in Table 10. All rolls have been returned to UTIG where they will be microfilmed and archived.

Table 9: EW95-11 3.5 kHz list of paper rolls returned to UTIG

	Start time	End time	Line numbers, transit
Roll#1	290:00:29	295:02:50	Transit from OBS#18 to Line1, Line1
Roll#2	295:03:00	297:23:30	Line2 ~ Line5
Roll#3	298:00:30	304:16:30	Line5 ~ Line19, transit to Honiala
Roll#4	304:23:20	306:11:00	Transit to OBS#1, OBS#1 ~ OBS#9 retrieve
Roll#5	306:13:19	307:23:00	OBS#10 ~ OBS#18 retrieve, transit to Line20
Roll#6	308:00:00	309:15:09	Transit to Line20, Line20
Roll#7	309:17:30	311:09:04	Line20 ~ Line22
Roll#8	311:09:30	318:23:23	Line22 ~ Line43, transit to Fiji

Transceiver

The transceiver is the Edo Western Corporation's Solid State Sonar Transceiver Model 248E. The transceiver determines the frequency, power and length of the sounding pulse, transmits one sounding pulse for each trigger pulse received from the recorder, and amplifies the echoes picked by the transducer. The transceiver consists of a transmitter controlling the sending signals and a receiver which amplifies the echoes. The transceiver will add either Auto Gain Control (AGC) or Time Varying Gain (TVG) characteristics to the signal during amplification.

The transmitter controls signals sent to the transducer and selects the signal's pulse width. The selection has four channels:

- SHORT (3.5 kHz = 0.15 ms, 12 kHz = 0.25 ms)
- MEDIUM (3.5 kHz = 0.8 ms, 12 kHz = 0.8 ms)
- LONG (3.5 kHz = 12 kHz = 3.5 ms), and
- EXTERNAL

The receiver has four modes of gain control for amplification of signals; TVG, FAST AGC, SLOW AGC, and MANUAL. Either the TVG or MANUAL mode was selected for EW95-11. The TVG controls a gain of the amplifier and acts as a mute. Immediately after transmitting the signal, the gain of amplifier attains a minimum valude of 40 dB. The gain is increased at a rate proportional to the spreading loss of sound in the water for approximately the first 100 ms. The start time of TVG can be changed. The TVG is not activated until a prescribed delay time after the signal is transmitted. After the delay time passes, the TVG activates and the gain is increased to 60 dB. This function is used for subbottom profiling by delaying the TVG until the bottom signal has returned. On arrival the bottom return, the gain is increased to normalize the weaker echoes from the deeper subbottom layers.

Recorder

The recorder in science laboratory is a Thermal Graphic Recorder Model 9802, EPC Laboratories. The recorder controls the timing of the system and generates a trigger pulse. The trigger pulse is a request for the transmission of a sounding pulse at the beginning of each sweep of its stylus. The stylus records the resultant echo signals during the remainder of the sweep.

The trigger time interval is controlled and determines the interval at which signals are sent from the transducer. A one (1) second interval time was used during EW95-11. In deepwater areas, a change of recording start time is required. The delay length of starting records can be changed over an interval from 1/32 to 4 seconds. The delay time of starting records can be changes using a personal computer adjacent to the recorder and linked at an external port. During EW95-11, automatic delay changes were used.

Transducer

The transducer performs two functions:

• converts the high-power electrical output of the transmitter part of the transceiver into a high-power acoustic wave and;

• then converts the returning low-power acoustic echoes into an electrical signal for amplification and processing by the receiver section of the transceiver.

The following manuals in the science lab were used as sources of technical information:

• Instructional manual for EDO Western Corporation's Model248E Solid State Sonar transceiver, report no.13210
• Operator's manual EPC9800 series recorder remote application software, EPC LABS INC.
• Operator's manual 9802 series thermal graphic recorder, EPC LABORATORIES

WEATHER STATION

Weather was logged at one minute intervals using R.M./. Young Precision Meteorological Instruments (26700 Series). Data is not checked and resides at LDEO. Data format is:

wx.rddd
Port bird is bird #1; starboard bird is bird #2.

94+022:00:00:00.244 3.4 231 9.3 15.4 13.2 21.1 271 261
date time tspd tdir wsi1 wss1 wsm1 wsx1 wdc1 wds1

6 12.6 15.9 15.6 20.7 261 253 6 66.7 66.7
wdm1 wsi2 wss2 wsm2 wsx2 wdc2 wds2 wdm2 tcur tavg

66.5 67.0 66 58 68 1016.8
tmin tmax rh rhn rhx baro

tspd = true speed
tdir = true wind direction
wsi1/2 = wind speed, instantaneous, bird #1/#2
wss1/2 = wind speed, 60 second average, bird #1/#2
wsm1/2 = wind speed, 60 minute average, bird #1/#2
wsx1/2 = wind speed, 60 minute maximum, bird #1/#2
wdc1/2 = wind direction, current, bird #1/#2
wds1/2 = wind direction, 60 second average, bird #1/#2
wdm1/2 = wind direction, 60 minute average, bird #1/#2
tcur = temperature, current
tavg = temperature, 60 minute average
tmin = temperature, 60 minute minimum

tmax	= temperature, 60 minute maximum
rh	= relative humidity
rhn	= relative humidity, 60 minute minimum
rhx	= relative humidity, 60 minute maximum
baro	= barometric pressure

Data was logged during the following period:

DAY	TIME	COMMENTS
289	2330	start of cruise, started logging/processing
323	0000	end of cruise; stopped logging/processing

COMPUTER NETWORK ON EWING AND SYSTEM-RELATED DATA CRASHES ON EW95-11

System use by UTIG group

The UTIG brought the following equipment to the ship:

- 2 (two) 2GB hard disk
- 1 (one) 3480 tape drive (stacker)
- 1 (one) Hi-density 8-mm drive

These were placed on the onboard Sun computers in the following configurations:

On **"hess"**, a SUN Sparc10:
- 1 (one) 2 GB hard disc
- 1 (one) 3480 tape drive (stacker)

On **"splitter"**, a SUN Sparc20:
- 1 (one) 2 GB hard diskThe high density 8-mm drive turned out to be DOA. For this reason, we lent them the use of our 8-mm drive, installed on hess. Both splitter and hess reside in the non-realtime segment of our network. We further provided access to **"squid"**, a SparcIPC, **"heezen"**, a Sparc10, for their purpose of onboard processing the MCS seismic data.

Early in the cruise, a 3480 tape jammed inside the UTIG stacker. LDEO support staff C. Leidhold and S. Budhypramono kindly took the stacker apart to dislodge the tape and put the stacker back on the working order.

It became clear to the UTIG group early in the cruise that they needed more disc space for onboard processing of MCS data. Budhypramono kindly offered space on Ewing computers and made space on **splitter** (1 GB partition) and on **hess** (700MB disc).

The UTIG group was also able to centralize their processing and cut down on heavy network traffic by not processing on one computer, writing data on another computer and making scratch files on another computer.

System use by ORI-CU group

The Japanese OBS group brought five laptop **PCs**, and they brought along a **multi-transceiver**, which were connected to to the Ewing **non-realtime network.**

System-related data crashes

Three network related problem occurred during the EW95-11 cruise, resulting in total network shutdown, and loss of MCS data. The three crashes occurred on:

JD 95+299:23:56:13.239 - JD 95+300:00:16:44.306
JD 95+310:19:48:35.671 - JD 95+310:20:00:01.703
JD 95+314:17:00:30.890 - JD 95+314:17:06:56.358

The first occurrence occurred near the end of a line and caused us to reverse the course and shoot back over the area of lost data with a total loss of several hours of survey time. The second and third incidents occurred at the beginning of a line, and were not retraced.

The first incident appears to haver been caused by heavy traffic in the **non-realtime network** which brought that segment of the network down.

The second incident was caused by a full **root partition in "heezen"** computer, caused by user filling up /tmp directory. Due to a surprising dependency of the **realtime network** to the **non-realtime network**, the **realtime network** also went down.

The third incident was caused by a loose ethernet connection on **"shark"** which is the **gateway** computer between **realtime** and **non-realtime network.**

Several steps have been taken by the Ewing systems analyst, S. Budhypramono, to prevent future incidents:

• The **realtime network** relies on **"heezen"** computer, which is located on the **non-realtime segment** of the network for in-house LDEO software executables, along with the libraries. LDEO now have made **"moray"**, the logging computer a separate set of executables and libraries. This move should preserve the **realtime network** integrity, even if the **non-realtime** network is bogged down.
• Moved all the /tmp directory to a much larger disk, allowing for bigger scratch space for the science party to use.
• Secured ethernet connections on **"shark"**, and keep it "out of reach".

NAVIGATION BY S. COWLEY

Time logging

A true time clock (Kinemetric/TrueTime Division Model GPS-DC GPS Synchronized Clock) logged time at one minute intervals throughout EW95-11. The True Time clock is used to adjust the CPU clock of the logging computer. The logging computer captures the continuous time records from the clock and provides these as a service to the rest of the network via a UDP broadcast. This enables the computers on the network to adjust their CPU times to UTC time.

Time logging for EW95-11 was conducted during the following interval:

DAY	TIME	COMMENTS
289	2330	start of cruise, started logging/processing
323	0000	end of cruise, stopped logging/processing

Logging of speed and heading information

Speed and heading information was provided by a Furuno CI-30 2-axis Doppler speed log mounted on a Sperry MK-27 gyro. This information was logged at 3 second intervals with visual checks of data plots. Smoothing was carried out to provide a mean value of all good values within the same minute.

Time logging for EW95-11 was conducted during the following interval:

DAY	TIME	COMMENTS
289	2330	start of cruise, started logging/processing
323	0000	gyro stopped working, logging suspended.

Navigation using GPS

The principal means of navigation aboard the R/V Maurice Ewing is the global positioning system (GPS). This system has been developed by the U.S. government to provide precise, all-weather, 24 hour per day navigation for ships and military operations throughout the globe using a constellation of GPS satellites in different orbits. The GPS program began with funding by the U. S. Department of Defense in 1972 when prototype Block I GPS satellites as well as a ground support network were established. This phase of the program ended in 1989. Since then more coverage has been added in the form of more advanced Block II production satellites whose positions in orbit are more precisely monitored. The orbits of the Block II satellites have been arranged to insure that there are three or more satellites visible by any GPS receiver at any time of day or night or in any geographic locality. Block II GPS satellites are collectively termed NAVSTAR satellites, an acronym for Navigation System with Time and Ranging.

The NAVSTAR satellites receive signals from the control segment and transmit signals to the user segment. The control segment monitors and tracks the NAVSTAR satellites, synchronizes their operation, performs satellite position computations and transmits orbital and corrected time data to the satellites. Synchronization of time between satellites insures that each satellites position is accurately known.

The data transmitted to the user consists of six different types:

1) **Health data** which indicates the quality of the navigation signals.
2) **Ephemerides** describe the detailed orbital characteristics of the satellite from which it is transmitted.
3)The **satellite constellation almanac** describes the course orbital data for all the satellites in the constellation. These data are used for satellite visibility prediction.
4) **Time**. Synchronization of time between satellites insures that each satellites position is accruately known.
5) **Ranging signals** are used to calculate the position of the GPS receiver on board ship from the known position of the satellite.
6) **Atmospheric data** to correct for delays in signals related to atmospheric mositure levels and local weather conditions.

User equipment tracks the NAVSTAR satellites and uses their signals to compute the position of the receiver. The degree of accuracy is governed by three main factors. The first of these is related to the level of accuracy granted by the U.S. government. For civilian use the signal is degraded deliberately for security reasons. This is referred to as selective availability, or "SA". The second factor is the receiver design, or the choice of codes, carrier frequencies, or the number of channels employed. Finally, if differential corrections are applied, the quality of the position-finding operation is increased.

The five most common GPS error sources and their approximate sizes include:

1. **Selective availability errors**: 30 m
2: **Ionospheric delays**: 20 m-30 m by day, 3-6 m by night.
3. **Troposheric delays**: up to 30 m.
4. **Ephemeris errors**: less than 3 m (without S.A.)
5. **Satellite clock errors**: less than 3 m (without S.A.)

To operate in differential mode two GPS receivers are required. One receiver remains at a known, fixed location on land. The location of the second receiver is unknown. In our case, the unknown receiver is the GPS receiver onboard the Ewing. The purpose of the differential GPS system is to use the reference station to measure the errors in the GPS signals and to compute corrections to allow for these errors. These corrections are then communicated in real time to the receiver on the ship where they are combined with the signal from the satellites to the overall solution for a position. This operation is valid because errors at the reference station and the ship are usually common.

GPS mode used during EW95-11

The Ewing has both differential and 2D or 3D operating mode capabilities. During EW95-11, only the 2D mode was used. The GPS receivers on board are two Magnavox 4200D receivers supplemented by a third Trimble NT200D receiver. Three or more satellites visible to a GPS receiver via an antenna on the uppermost deck insures the precise calculation of the ship's position. The ship's GPS-derived position is displayed on monitors in the science lab and bridge. In the event of a temporary loss of GPS coverage, the ships navigation system defaults to a Furuno CI-30 three axis Doppler sonar speed log to provide location dead reckoning information (i.e., estimates of the ship's position based on its last known GPS position).

To operate in differential mode requires a reference station close by on a land mass. At present such stations are only found mainly on the continental United States. Therefore on cruise EW95-11 in the Solomon Islands, we operated in 2-D non-differential mode for the duration of the cruise and did not use the differential mode of the ship because we did not establish any onland reference points.

On EW95-11, GPS fixes based on the minimum number of 3 satellites were logged at 10 second intervals on GPS MX-4200 #1 and #2. Because of the good coverage now available worldwide, it is not necessary to track satellites low on the horizon. Low horizon satellites give excessive errors related to large ionospheric and troposheric errors.

The MX4200D is a 6-channel continuous tracking GPS receiver. The navigation algorithm is an extended Kalman filter. Eight states are estimated that include three position, three velocity, a clock offset and a frequency offset state. The navigation filter operated in standalone mode for the duration of the cruise rather than the differential mode. The altitude of the antenna is known at a fixed point on the ships mast approximately 30m above sea level so that 3D operation mode was not required.

Output of GPS data is via an equipment port which is designed to communicate with devices which use transmit and receive standard NMEA messages. The NMEA-0183 standard provides for asynchronous transmission with a single talker and multiple listeners per line. The NMEA data is what becomes logges on the navigation tape.

There is also a raw data output port which provides periodic outputs of satellite pseudoranges, navigation data, satellite ephemeris data, almanac data, and differential corrections if available.

The following checking procedure was followed:

- dilution of precision maximum: north = 4.0, east = 4.0
- carrier signal-noise ratio minimum: 35.0
- standard deviation maximum: north =4.0, east = 4.0
- time step maximum: 3
- speed maximum: 30.0
- compared GPS speed and course with Furuno smooth speed and heading
- compared positions with Transit-Furuno navigation
- reject fixes with high drifts in navigation
- reject fixes producing Eotvos correction errors in gravity larger than 5 mGals

Positions were interpolated at 00, 30 seconds of each minute and smoothed positions were interpolated with 9 or 41 point running average depending on the quality of GPS data and the sea state.

The GPS data has a sinusoidal wave which is assumed to come from some degrading of the GPS quality for civilian usage. This wave seems to vary in period and shapes and is not a perfect sine curve. The periods are less than 20 minutes. The amplitudes tend to vary over 24 hours and the sea state condition. This degrading produces a false ship's track in real-time navigation and introduces extreme errors, up to 10 mGals, in the Eotvos correction for the gravity. As this problem varies in its intensity depending on the sea state and GPS data quality itself, several methods of data reduction has been developed to achieve the best possible navigation.

1. A 9 point (4 minutes) GPS smoothing
2. A 9 point (4 minutes) GPS smoothing, decimated to a 20 min. fixes
3. A 41 point (20 minutes) GPS smoothing
4. A 41 point (20 minutes) GPS smoothing, decimated to a 20 min. fixes

It should be noted that the use of 41 point smoothing causes the turn to "widens". Hence, in the instances where a 41 point smoothing is called for, the GPS data at and around the turn are decimated to 20 minutes.

GPS logging for EW95-11 was conducted during the following interval:

DAY	TIME	COMMENTS
289	2330	start of cruise, started logging/processing
323	0000	end of cruise; stopped logging/processing

One minute navigation plots

A "1 minute navigation" is produced from the above GPS sources. Acceptable fixes are merged at 1 per minute with priority given to GPS. The smooth speed and heading data described above is used to fill any gaps of 2 minutes or longer between fixes by computing 1 minute dead reckoning positions corrected for set and drift between fixes. The dead reckoning positions are produced at 00 seconds of each minute.

The final EW95-11 data is one minute navigation and is in the following format:

FORMAT: n.ddd

```
yy+ddd:hh:mm:ss.mmm N 12 12.1234 E 123 12.1234 id 123.1 12.1
yr. day  time          lat.            lon           id  set  drift
```

The Lamont database is a 1 minute navigation file in NetCDF format.

One minute navigation plots were generated during the following interval on EW95-11:

DAY	TIME	COMMENTS
289	2330	start of cruise, started logging/processing
323	0000	end of cruise; stopped logging/processing

Figure 36 provides an illustration of a one minute navigation plot from MCS line 11A on EW95-11. The open ellipses show GPS positions recorded directly onto the Navlog tape during data acquisition. The closed circles are best pick positions based on the three GPS receivers and dead reckoning sources that were sampled at a 1 minute interval. These positions have also been filtered. In this example, there is probably no dead reckoning source used in the plot because there were sufficent satellites visible at all times to provide continuous GPS coverage.

At 8°31.05' and 161°49.8, there is a area of large degree of error in the GPS positions. The lengths of the ellipse axes in the latitudinal and longitudinal direction show NDOP and EDOP, respectively. DOP values have been normalized to DOP/50 inches. This large error is related to a change in the satellites used to calculate the ship's position at this time in the survey.

GRAVITY MEASUREMENTS BY S. MIURA, N. TAKAHASHI, AND M. SHINOHARA

Introduction

A gravity survey was carried during EW9511 using a Bell Aerospace marine gravity meter for the entire duration of the cruise (October 17 - November 19, 1995). Gravity data measured by the gravity meter were processed onboard to determine the free air gravity anomaly (FAA) that is plotted along the ship's tracks in Figure 40.

Gravimeter and data processing

A Bell Aerospace BGM-3 marine gravity meter was used to measure the gravity field. The time interval for sampling of gravity measurements is 1 second. Because the current BGM-3 output has double counts every few minutes, the following scheme has been implemented until the hardware and interface code can be corrected:

- The data are filtered using a 1 minute Gaussian filter. This will narrow the output spike noises and make them better. Output interval has been hard-wared to every 15 seconds.
- The output are passed through an 8 minute Gaussian filter using a robust algorithm that plots outlier points as spikes that can edited out. The FAA is obtained from these corrected output data.

First, we calculate Eotvos correction using the ship's velocity. The ship's velocity is smoothed by 5 point running average throughout the cruise. The Eotvos correction is calculated by

$$Ec = 7.5038 \cdot Ve \cdot \cos(\varphi) + 0.004154 \cdot Ve^2 \quad (1)$$

where Ec is Eotvos correction, Ve is a ship velocity for east direction, and j is latitude of the ship position. Then we get the corrected gravity value through

$$Gc = Gr + Ec - D - Ds \quad (2)$$

where Gc is corrected gravity value, Gr is the raw gravity value, D is the drift value of the gravitymeter and Ds is the dc shift value of the gravimeter. The 1980 International theoretical gravity value is given by

$$Go = 978.0327 \cdot \{1 + 5.3024 \times 10^{-3} \sin^2(\varphi) - 5.8 \times 10^{-6} \sin^2(2\varphi)\} \quad (3)$$

where, Go is the theoretical gravity value.

Finally, we obtained the FAA as

$$FAA = Gc - Go \quad (4)$$

where FAA is the free air gravity anomaly value. The FAA is calculated using Eqs (1)-(4). A file including the FAA values with the ship's position data at 0 second of each minute was created every day during the cruise. The used D and Ds value for the calculation during this cruise are listed in Table x.

EW95-11 gravity data

We obtained FAA's throughout the EW9511 cruise period because the gravimeter operated continuously (Fig. 40). Unfortunately, there are a few short gaps of FAA data related to equipment problems. Tables summarizing drift and dc shift values and the observation period for the EW95-11 cruise are given below.

Table 10. Used drift and dc shift values in the EW9511 cruise.

Drift value

Begin		End		
Julian day	Time	Julian day	Time	Drift (mgal)
289	14:03	291	23:48	0.0
291	23:49	296	04:36	0.1
296	04:37	300	09:24	0.2
300	09:25	304	14:12	0.3
304	14:13	308	19:00	0.4
308	19:01	312	23:48	0.5
312	23:49	317	04:36	0.6
317	04:37	323	00:00	0.7

Dc shift value

Begin	End			
Julian day	Time	Julian day	Time	Dc shift (mgal)
289	14:03	302	23:59	18.3
303	00:00	323	00:00	18.8

Table 2. Observation period of the gravitymeter in EW9511 cruise.

Begin		End	
Julian day	Time	Julian day	Time
289	14:03	293	23:55
294	00:01	299	23:56
300	00:17	310	19:48
310	20:01	323	00:00

Figure 40 plots the regional free air anomalies in the in the survey area onto the Gebco bathymetric basemap. This map reveals the expected fundamental correspondence of FAA's with bathymetry. For example, the North Solomon and San Cristobal trenches are characterized by negative FAA values while the Ontong Java and Louisiade Plateaus are characterized by positive values.

Plots of the bathymetry from Hydrosweep measurements and FAA's along each of the 43 MCS lines collected during EW95-11 including additional transit lines during the survey are shown in Figures xx - xx. For comparison purposes, the FAA's from the GEOSAT satellite are also shown. Generally, the shipboard FAA's show good agreement with the GEOSAT FAA's. Discrepancies between the shipboard and GEOSAT FAA anomalies reflect two factors:

• the shipboard FAA's contain a short wavelength component and therefore have a higher spatial resolution

• the GEOSAT tracks at this latitude are spaced tens of kms apart and therefore have a lower spatial resolution. Continued declassification of the GEOSAT data set may improve this resolution.

Some areas showing discrepancies between the shipboard and GEOSAT data include the following:

• on the crossing of the North Solomon trench at line 9, a small bathymetric high at the base of the trench slope does not exhibit a shipboard matching FAA high. Seismic reflection results on line 9 indicate that this high represents a small accretionary prism of sedimentary material offscraped off the Ontong Java Plateau. This interpretation is consistent with the origin of the bathymetric high as an low density mound of sedimentary rocks accreted to the Malaita anticlinorium. The GEOSAT FAA is displaced seaward from the shipboard FAA.

• the GEOSAT FAA's are similarly displaced seaward on Lines 13 (Fig. xx) and Line 15 (Fig. xx) and therefore do not closely match the shipboard FAA.

These differences are probably caused by the wider spacing of the GEOSAT gravity tracks mentioned above.

MAGNETIC MEASUREMENTS BY N. TAKAHASHI AND S. MIURA

Introduction

A magnetometer observes and records the earth's magnetic field. We observed the spatial variability in the earth's magnetic field around the Solomon Islands using the proton magnetometer on the RV *Maurice Ewing* during EW95-11 (Fig. 43). The observation period of the magnetic survey was from October 19 to November 14, 1995 (GMT).

Equipment

The equipment V-75 proton magnetometers (the Varian Canada Inc.) is capable of measuring the absolute value and changes in the absolute value of the earth's total magnetic field intensity. The marine magnetometer consists of the V-75 electronics console, analog recorder and power supply all mounted in a cabinet complete with anti-vibration mounts, marine towing system and winch-to-console cable.

This equipment covers the worldwide field change of 20,000 to 100,000 nT in 10 ranges with a 50% overlap between neighboring ranges. The magnetic field range corresponds to that in the proton sensor and the proton signals were filtered by 800 - 4500 hz. The amplifier gain peaks at about 900 Hz to compensate for low proton signal amplitude at low fields. A typical overall amplifier gain at 900 hz is 540. The sampling rate of the recording is selective from 3,6,30 and 60 seconds. These outputs are available in visual, digital and analog forms. The performance specification of the magnetic system is as follows.

Sensitivity	+- 0.1 nt
Reference frequency accuracy	+- 1 ppm (25 degree)
Reference frequency stability	5 ppm/year
Accuracy (overall magnetometer)	+- 5 ppm

In general, the proton sensor is either two solenoids or toroidal coil wound around a core containing a proton-rich fluid. This magnetic system mainly consists of the marine sensor containing an omnidirectional noise-cancelling toroidal coil and the low noise marine towing cable. There are two types of cables: standard and flotation types.

The flotation cable is available for shallow water usage. The standard type was used for the deeper water EW95-11 survey. When an electric current (about 4.5 amperes) flows through the coil, a magnetic field of about 100 oersted is generated. Protons in the sensor become aligned along the direction of the magnetic field. The polarizing field is then removed very quickly, and the aligned protons begin precessing about the external magnetic field at a rate linearly proportional to the field intensity.

Magnetic observations during EW95-11

The observed period (UT) is as follows.

Begin		End
Oct.19 08:16	-	Oct.21 20:19
Oct.21 20:21	-	Oct.22 02:39
Oct.22 02:44	-	Oct.22 02:46
Oct.22 02:48	-	Oct.22 02:49
Oct.22 03:16	-	Oct.25 04:22
Oct.25 04:33	-	Oct.26 23:56
Oct.27 00:17	-	Oct.31 01:59
Oct.31 08:46	-	Nov. 1 17:53
Nov. 4 10:56	-	Nov. 4 21:15
Nov. 7 05:08	-	Nov. 9 14:50
Nov. 9 18:16	-	Nov.10 02:36
Nov.10 05:22	-	Nov.13 16:46
Nov.13 19:59	-	Nov.14 00:30
Nov.14 03:23	-	Nov.16 00:00

There are two large data gaps: one from Nov. 1 17:53 to Nov. 4 21:15 when the ship was in port at Honiara and during the recovery of ocean bottom seismometers; the second gap was from Nov. 4 21:15 to Nov. 7 05:08 (Fig. 43).

Other short data gaps are due to minor problems such as power failures and when the multichannel streamer was out of the water.

The sensor was towed 200 m behind the ship to sufficiently eliminate the magnetic effect of the ship body. Fig. 44 shows the configuration of the tow cable at the stern of the ship.

The sampling rate was 6 seconds. The received magnetic data were stored onto harddiscs of a workstation on the ship.

The magnetic anomaly data minus the IGRF90 (International Geomagnetism Reference Field 1990) was merged with the navigation data every 1 minite.

EW95-11 magnetic data

The magnetic profiles are compared with topography and the whole magnetic profile in both map view (Figs. 43) and along individual lines as illustrated using Line 1 (Fig. 45). Some notable features on the profiles are given below.

Magnetic highs are present:

- Off northern Malaita Island at the Eastern Ridge, the Central Ridge and the Western Ridge (Line 3, 5, 7, 9, 11, 13 and 15).
- Off eastern Malaita Island (Line 3 and T5)
- Off western Malaita Island (Line 1, 17 and 18).
- In the Woodlark Basin (Line 1 - Fig. 45)
- Between the Guadalcanal Island and the Santa Isabal Island. (Line 1 - Fig. 45)

Some positive peaks exist off northern Malaita Island which seem to be parallel to tectonic trends in the Malaita anticlinorium (Fig. 43). To the northeast of Malaita, peaks correspond to the prominent bathymetric highs of the western and central ridges.

To the north of western Malaita and to the north of Santa Isabel, there is not always a direct correlation between magnetic highs and topographic highs suggesting a complex basement structure at depth perhaps related to an older phase of deformation. Magnetic highs do correspond to the Ramos Ridge and Edwards Bank.

Magnetic lows are present:

- Along the trench axis of the North Solomon and San Cristobal trenches (Line 1, 3, 5, 7, 9, 11, 15, 17, 19, 26, 28, 30 and 32).
- On the Ontong Jawa Plateau (Line 1).
- On the Louisiade Plateau (Line 1, 2 and 3).
- On the southern slope of the Solomon arc (Line 1, 3, 41 and 43).
- Off northwestern Choiseul Island (Line 32).
- In the Central Solomon Trough (Line 43).
- In the New Georgia group (Line 33, 34, 35, 36 and 40)
- In the Nudha basin (Line 3)

Spatially high frequency magnetic anomalies are present:

- Off northern Santa Isabel Island (Line 1 and 19).
- Between Santa Isabel Island and the Florida Islands (Line 1 and T2).
- Around the New Georgia group (Line 35, 36, 40 and 41).

The width of this anomaly along the Line 1 is from the KKK faults to the off western Florida Island. This anomaly was also observed by a previous study (Cooper et al.,1986). This sharp, steep anomaly suggests that magnetized rock penetrates the shallow crust or is exposed on the sea bottom. Boulders of magnetite have been described from river exposures of Tertiary arc rocks in western Guadalcanal.

Reference

Cooper,A. K., M. S. Marlow and T. R. Bruns, Deep structure of the central and southern Slomon Islands region: Implications for tectonic origin, Geology and offshore resources of Pacific island arcs - central and western Solomon Islands, Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, v. 4: Vedder, J. G., Pound, K.S. and Boundy, S.Q., editors, p175-175, 1986.

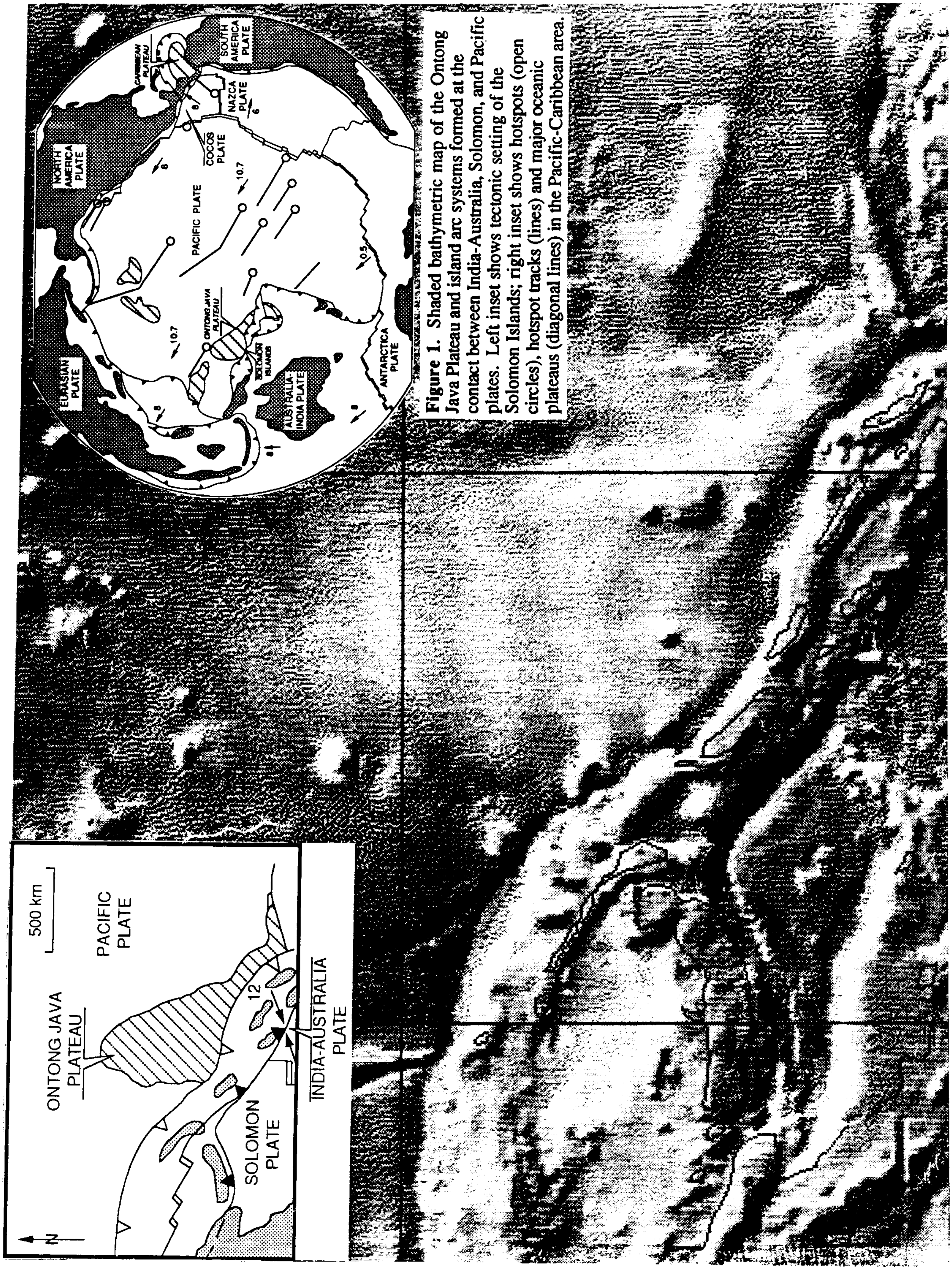


Figure 1. Tectonic setting of EW95-11 study area in the Solomon Islands and Ontong Java Plateau.

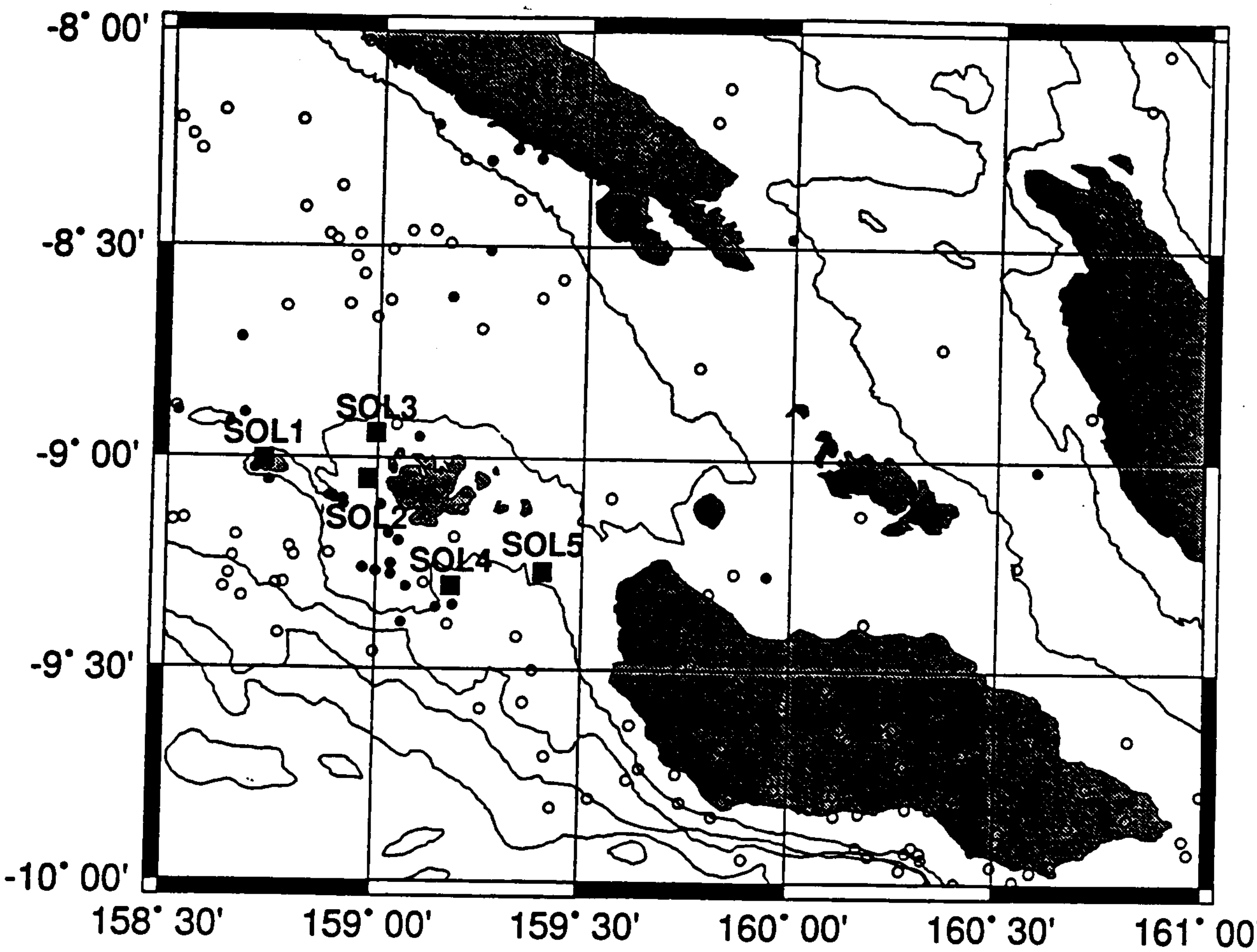


Figure 2. Location map of Russell Islands passive OBS pilot study carried out during August-September of 1994 by Suyehiro and Shinohara. Large island to east of study area is Guadalcanal. Black squares represent OBS sites SOL-1 through 5. Dark circles are preliminary epicenters recorded by the 1994 OBS experiment and open circles are epicenters determined by ISC from 1980 to 1990. Results will be presented at the 1995 Fall AGU meeting in San Francisco, California.

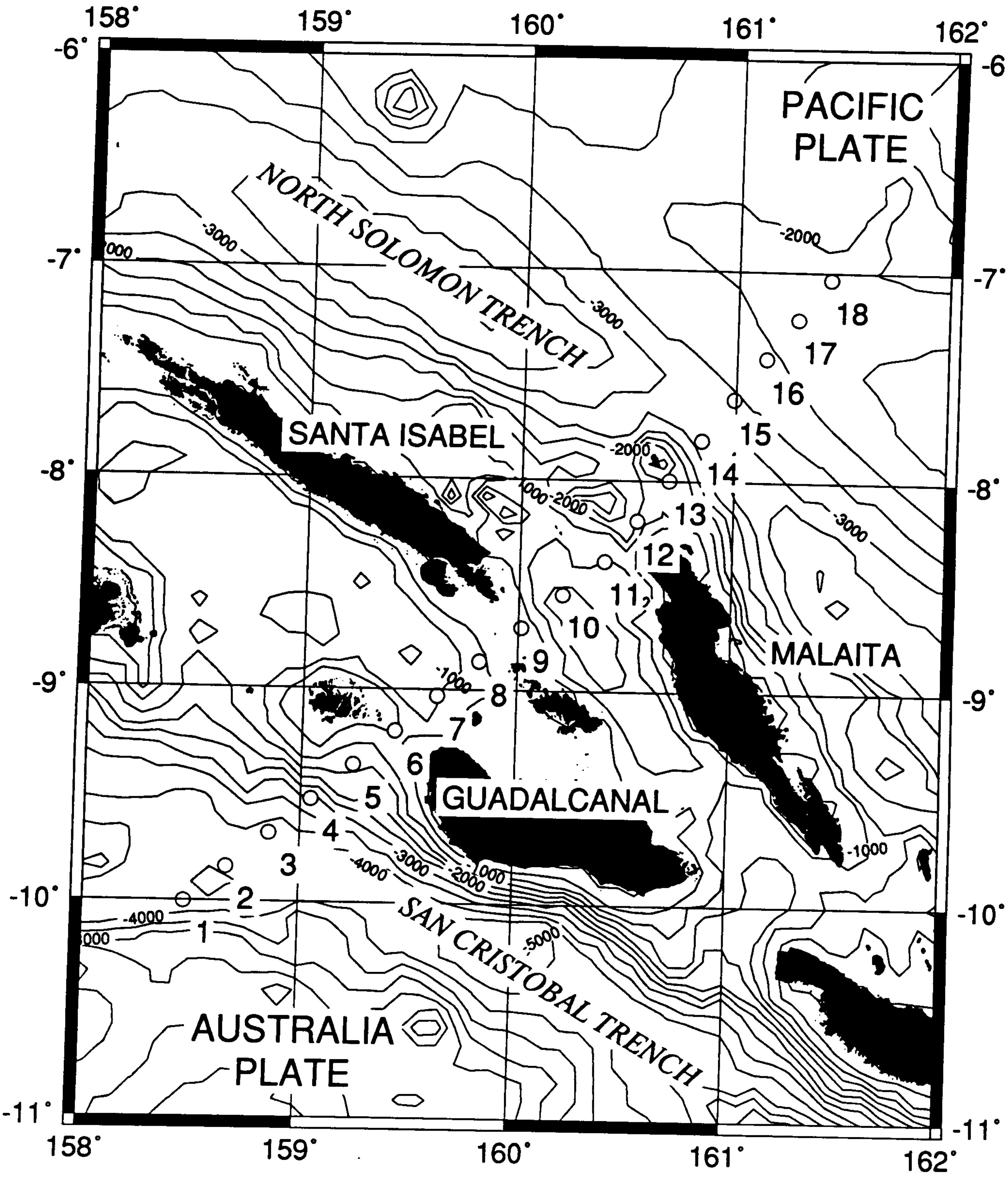


Figure 3. Location map of OBSs deployed along Line 1 of active EW95-11 study carried out from October 19-November 2 and 3, 1995. The slight kink in the line near 8°20 N is to allow the ship to pass through the deepest water strait between Malaita and Santa Isabel.

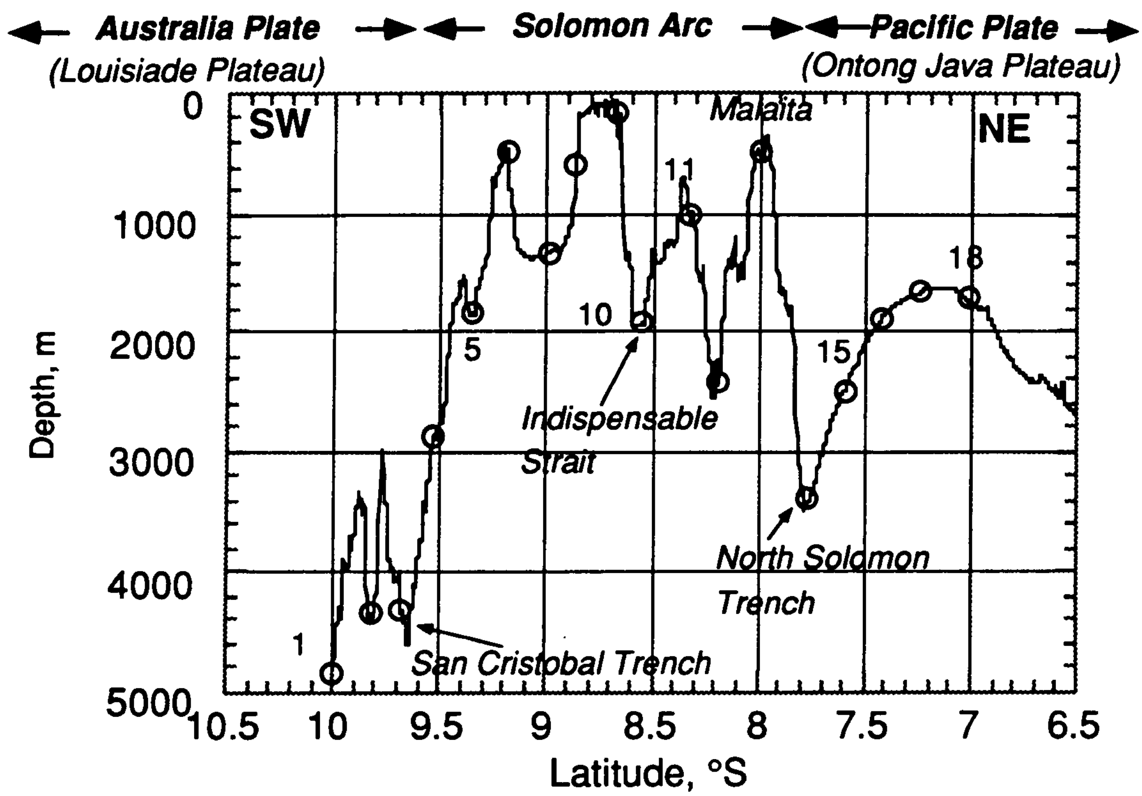


Figure 4. Locations of OBSs along Line 1 plotted on a bathymetric profile.

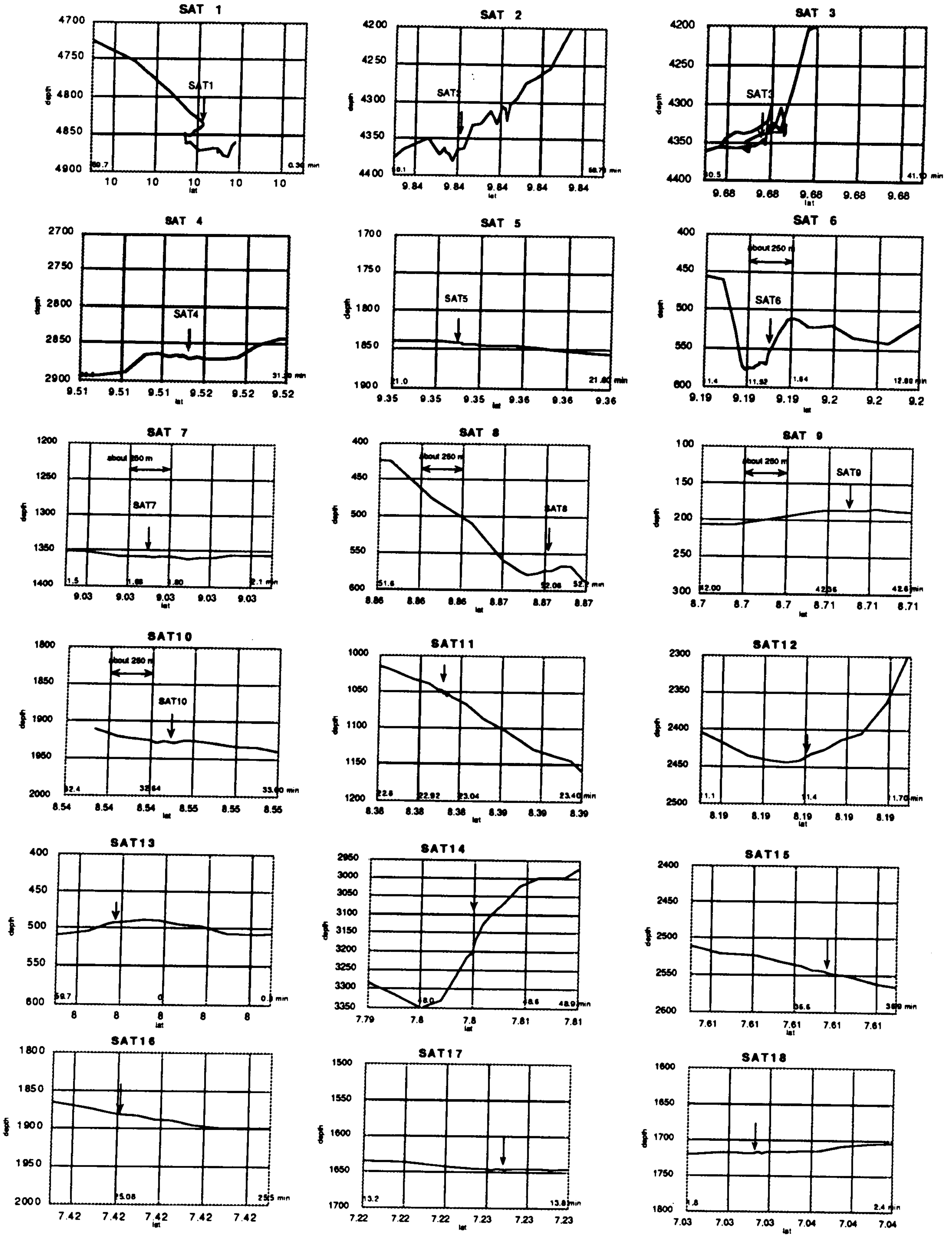


Figure 5. Detailed bathymetry of OBS sites SAT-1 through 18. Note high bathymetric relief at OBS sites SAT1-3 on the young oceanic crust of the Woodlark basin.

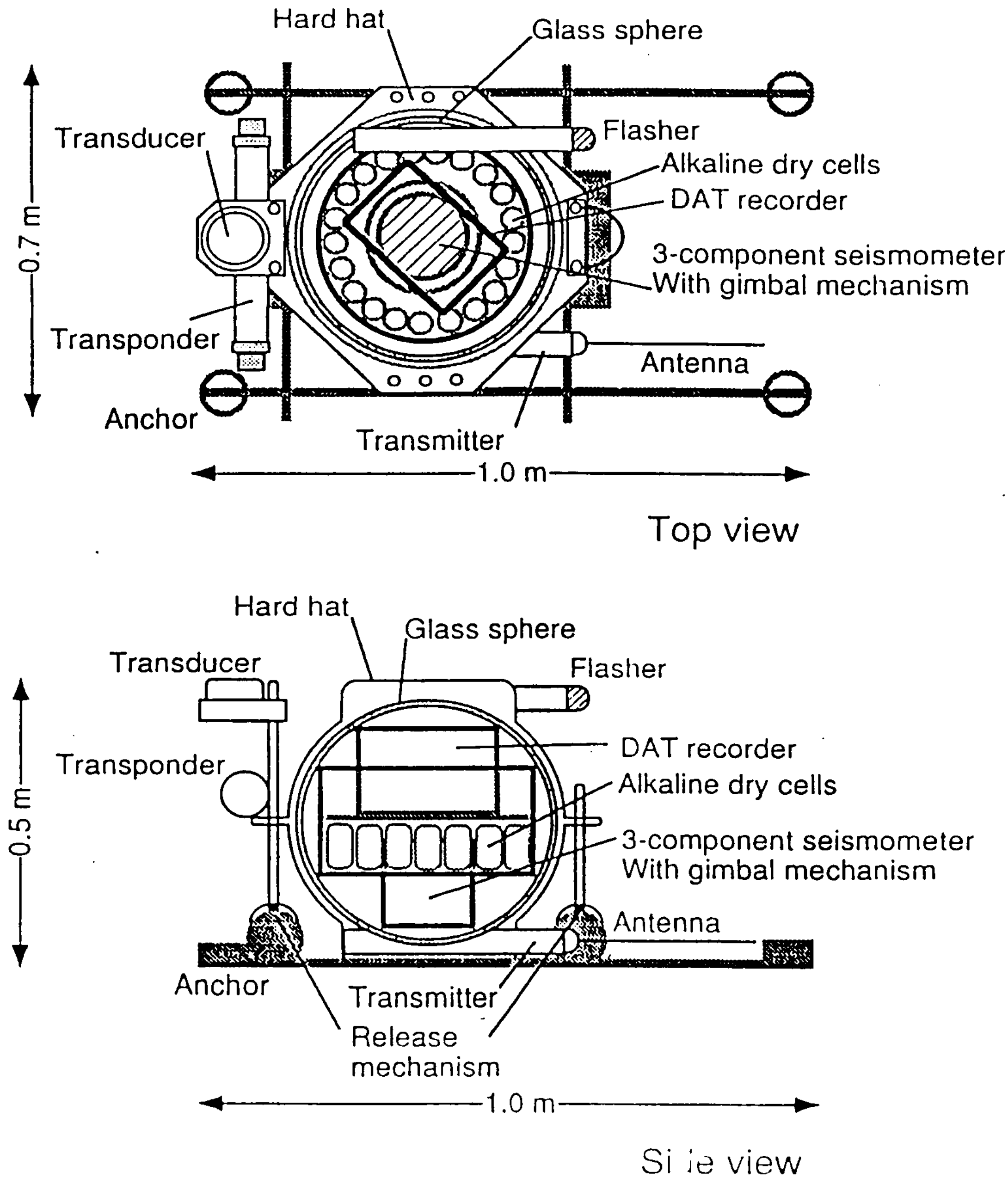


Figure 6. Schematic drawing of ORI-designed OBS from Shinohara et al. (1993). This OBS design was developed at ORI in 1991 and has undergone several minor modifications since that time. See text for discussion.

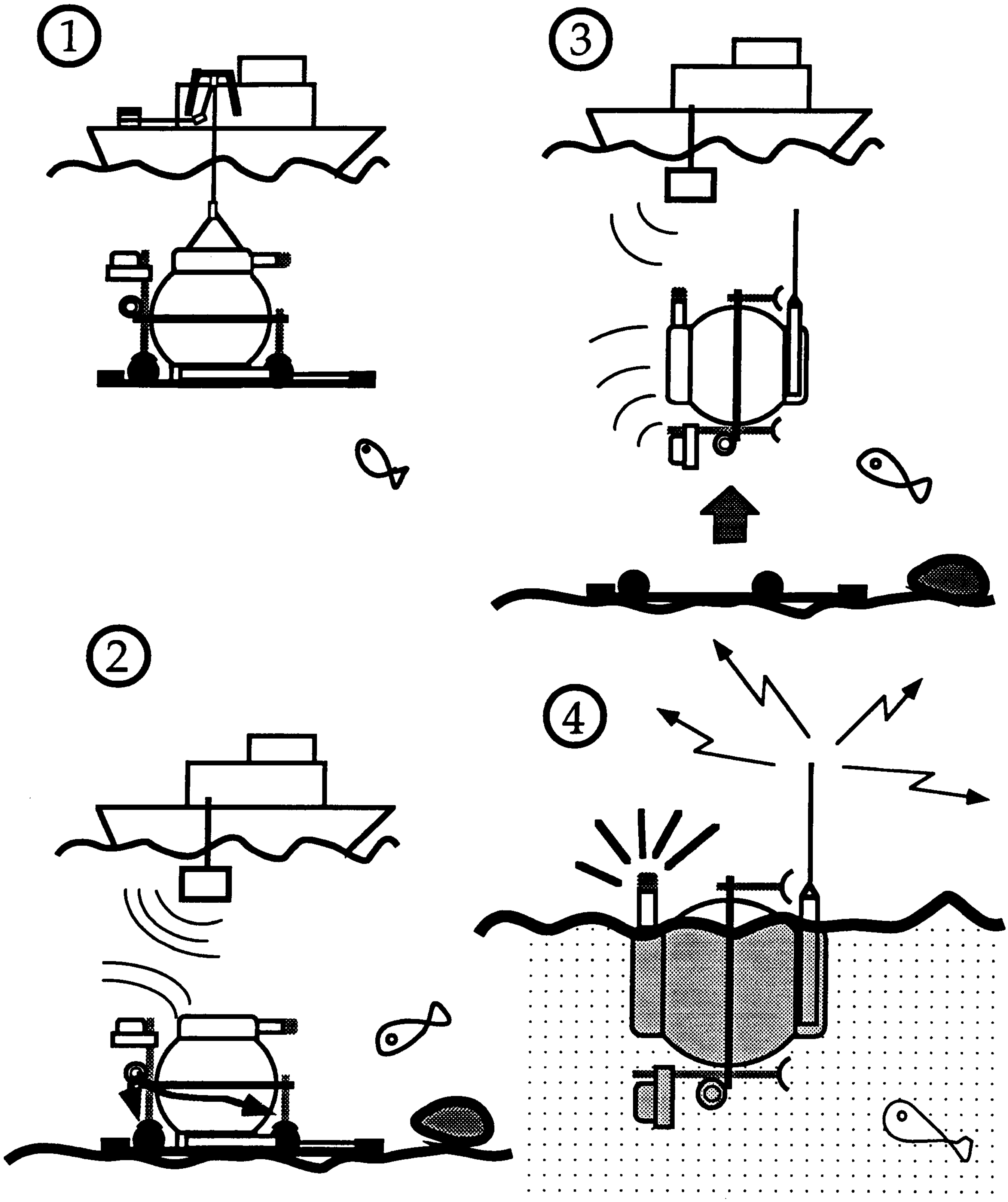
Figure 7. Schematic drawing showing four critical stages in the deployment and recovery procedure of OBSs used during EW95-11:

1. **For deployment, an OBS is launched from the starboard waist deck of the Ewing.** A rope attached to a pulley and attached to the stern capstan and the side A-frame crane was used to raise the OBS above the level of the deck and lower it to the sea surface. The side A-frame was lowered to move the OBS away from the side of the ship before it was lowered to the sea surface. Using a pole, the release hook was unfastened from the top of the OBS after it was lowered to the sea surface.

2. **For recovery, an acoustic release command is sent from the Ewing to the transponder on the OBS on the seafloor for it to begin the release of the buoyant glass sphere by electrolytic melting at the contact between the sphere and the frame anchoring it to the bottom.** When the release command was accepted by the transponder, it would respond with 16 pings and would begin to supply an electrical current to a small stainless steel plate connecting the anchor to the glass sphere. Electric erosion and failure of the metal plate usually took less than 15 minutes.

3. **OBS starts ascending to the sea surface.** During ascension, the OBS rotated about an angle of 90°. This rotation allows the radio beacon antenna and flash light to stand vertically above the sea surface. The rate of ascension is approximately 0.75 m/second. At any time during the ascension, the transponder could estimate the distance between the OBS and the ship.

4. **OBS reaches the sea surface and begins to transmit a radio signal.** At nighttime a flashlight is turned on. When the ship is adjacent to the OBS, the hook at the top of the unit is hooked with a pole and the unit is hoisted onto the starboard waist deck.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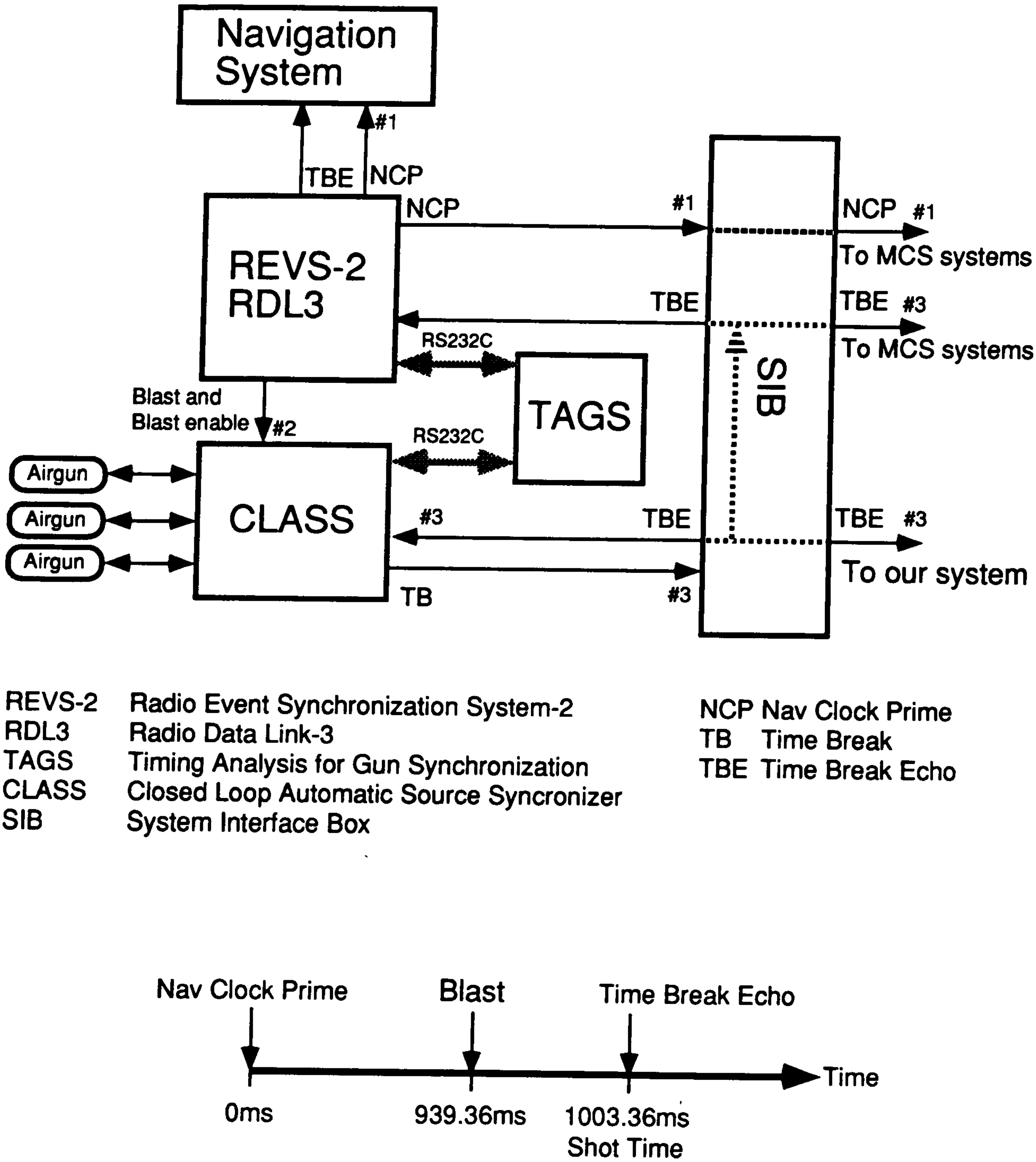


Figure 8. Schematic diagram of airgun control system and timing of airgun shooting used by OBS group on EW95-11. The time break echo (TBE) which indicates the time of the airgun shot is recorded by the shot time recording system by the SIB.

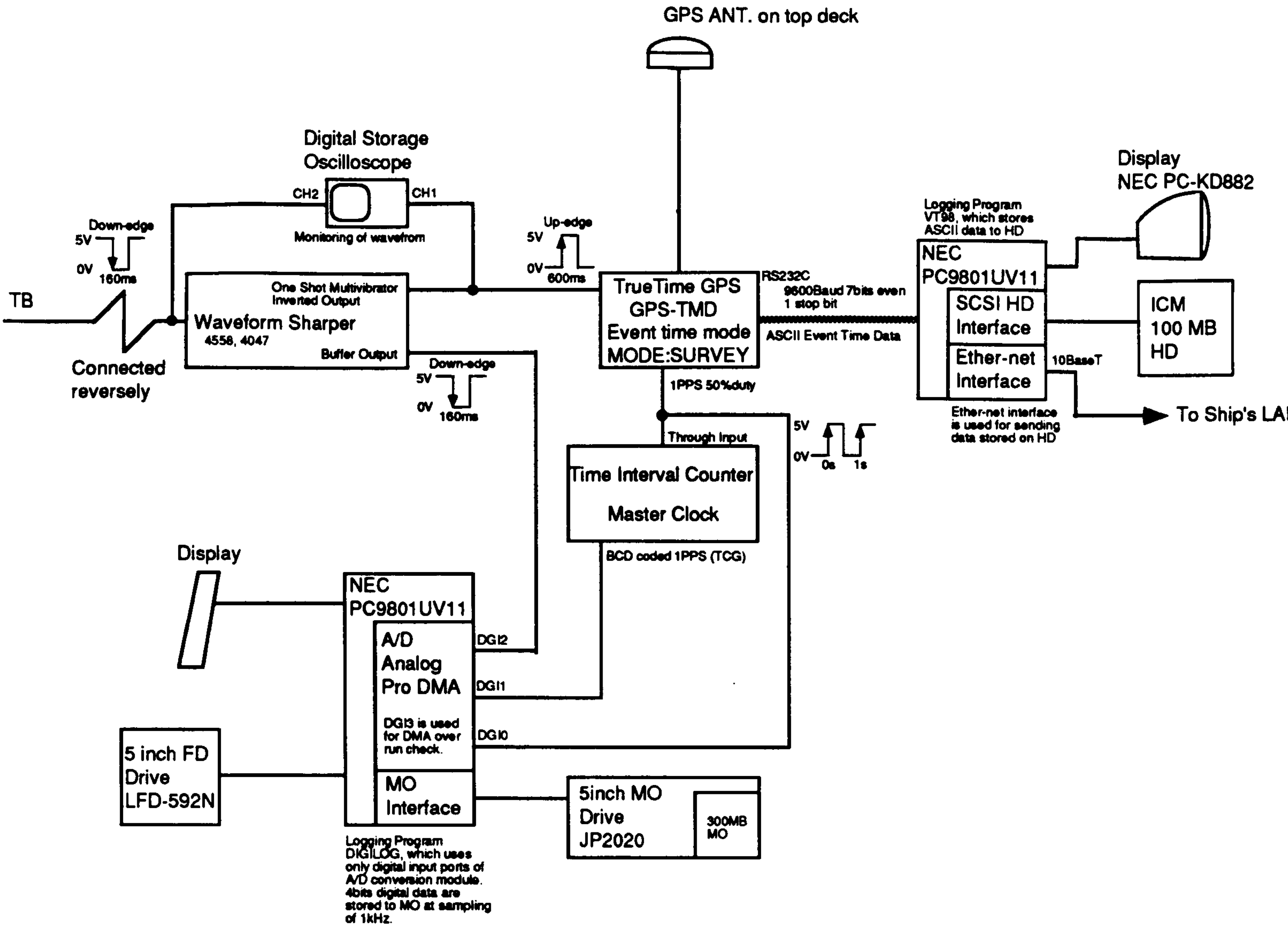


Figure 9. Flow chart of shot time recording system used for OBS data on EW95-11. The time of the time break echo (TBE) was measured using TrueTime GPS and stored to hard disc in an ASCII format. In addition to the time of the TBE, the TBE waveform was recorded at a time interval of 1 ms.

EW9511 MCS Lines

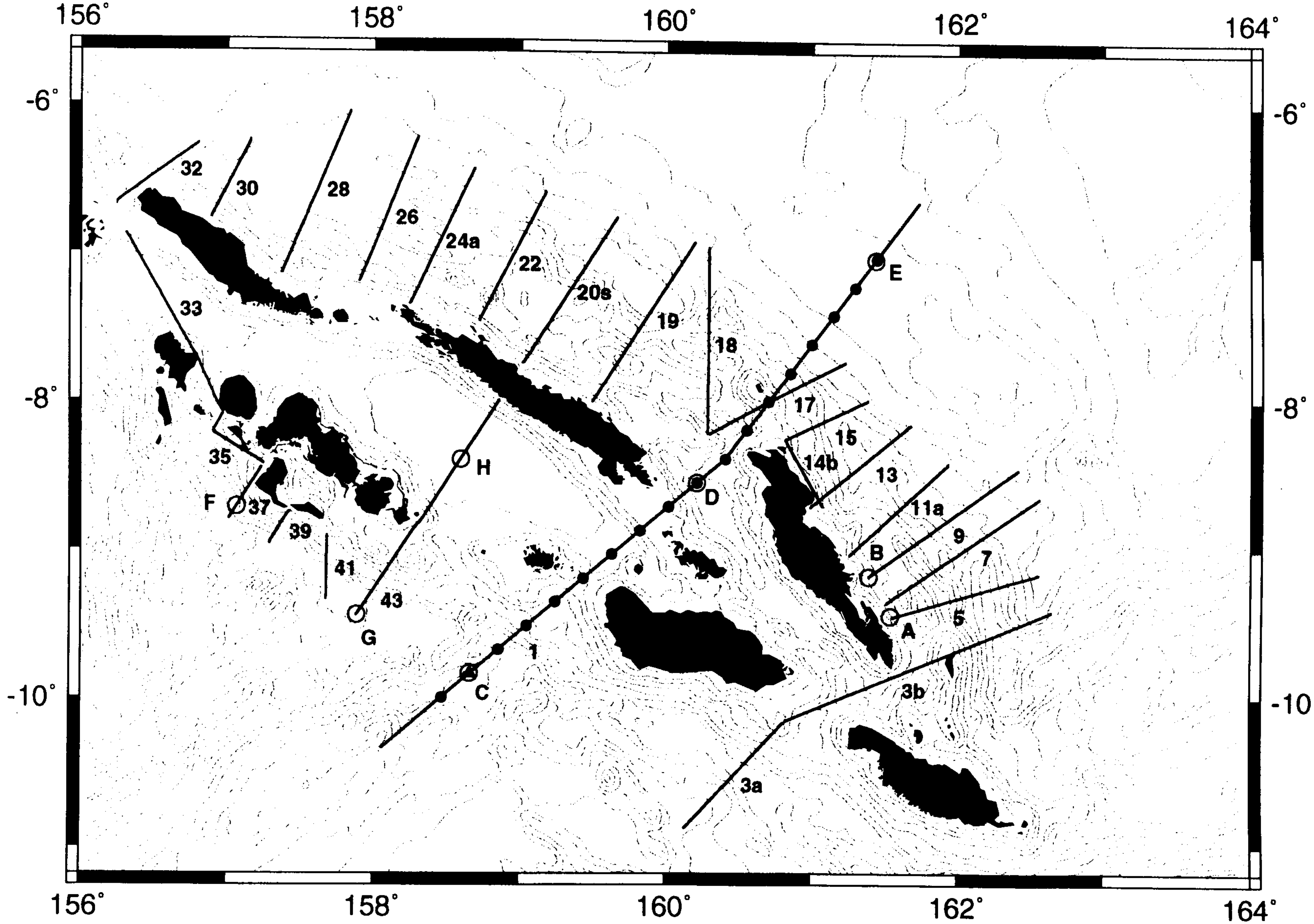


Figure 10. Track map of EW95-11 cruise showing MCS lines identified by numbers 1 through 43, OBS sites 1-18 (filled black dots), and XBT sites A through H (open circles).

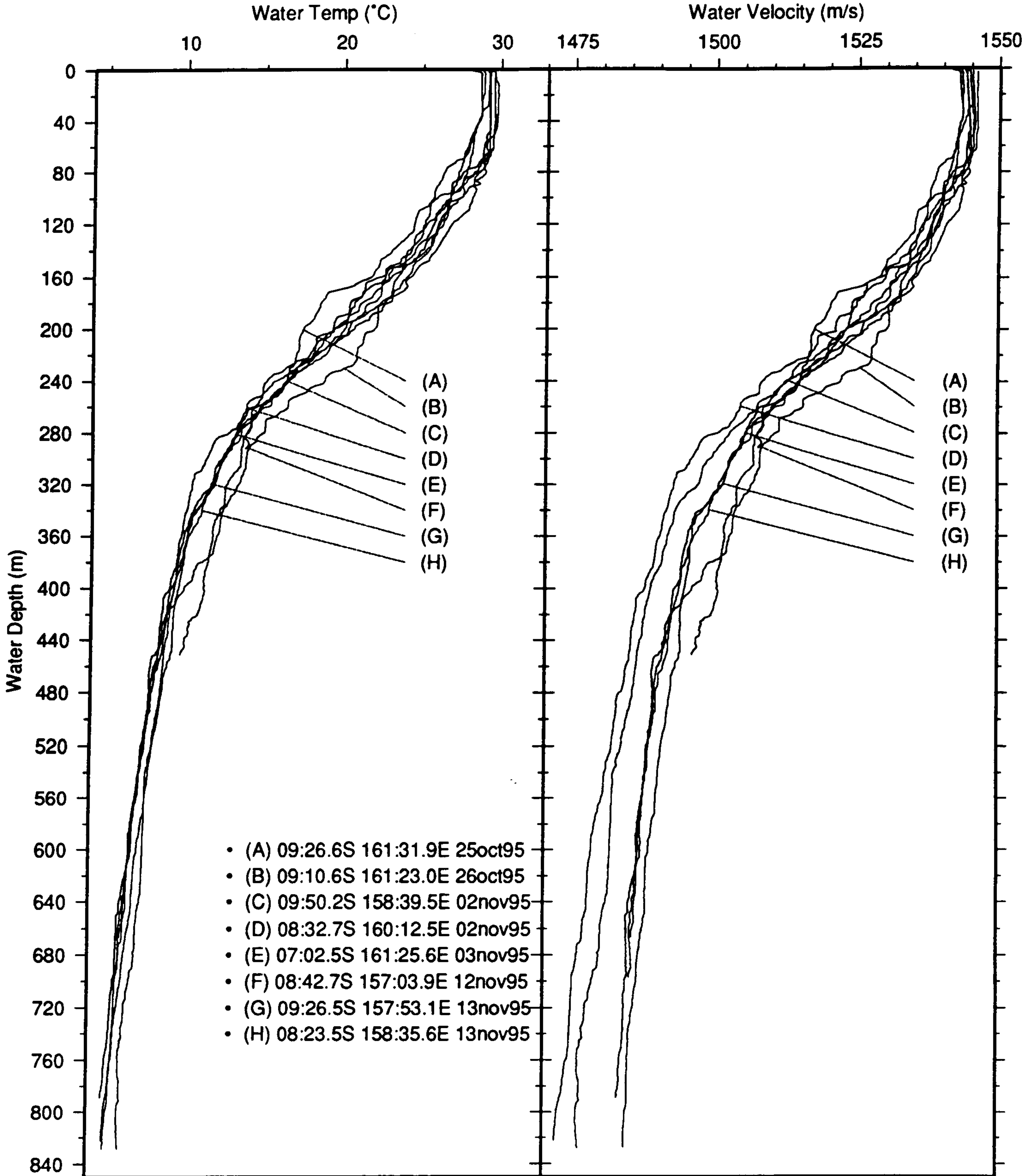


Figure 11. Comparative plot of all XBT measurements made during EW95-11. Individual XBT sites are identified by letters A through H. The locations of sites A through H are shown on the track map in Figure 10. Note similarity in temperatures at all sites.

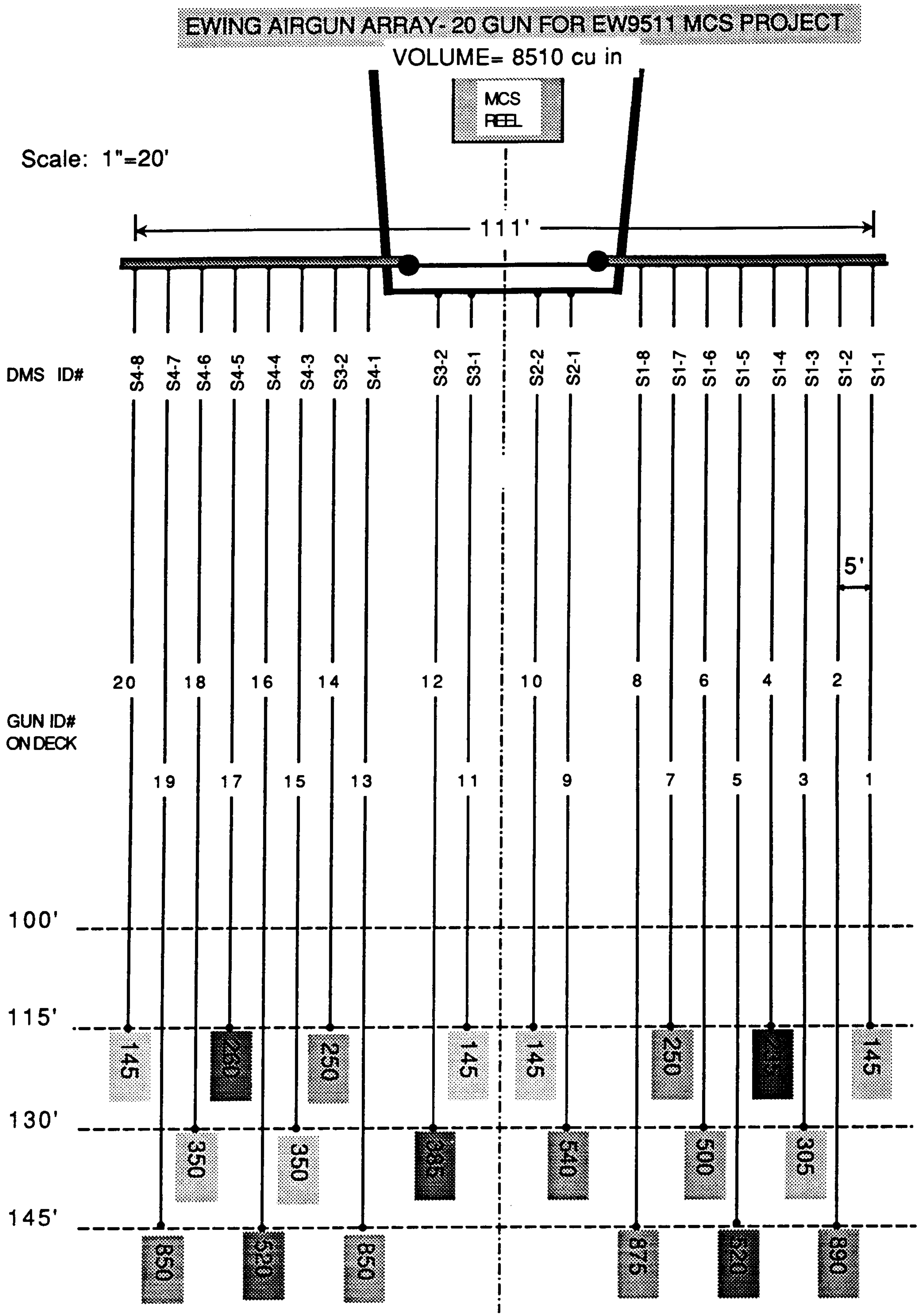


Figure 13. Scaled schematic drawing of 20 airgun array used for EW95-11 project on RV *Maurice Ewing*. Guns are viewed in a map view with the stern of the ship in the top center of the diagram (scale 1 inch = 20 feet). Guns and their respective air capacities in cubic inches are shown in the shaded boxes at the bottom of the drawing. Total air capacity of the array used for EW95-11 was 8510 cubic inches. (NO FIGURE 12 IN TEXT)

Model 5010 DigiBIRD Specifications

PHYSICAL CHARACTERISTICS

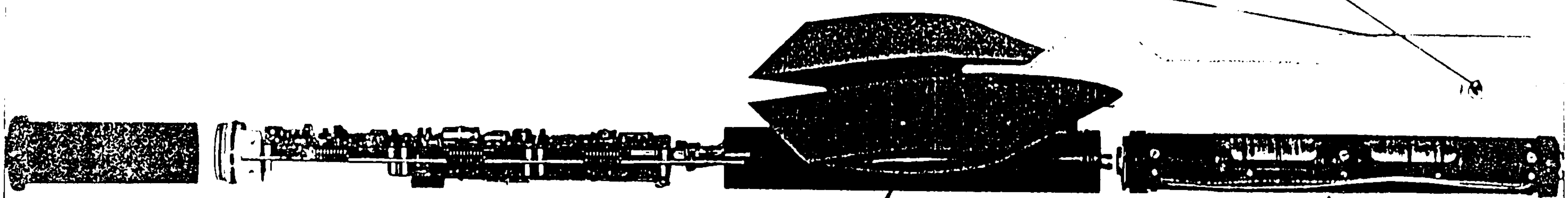
Length:	48.2 inches (1.2 m)
Weight:	17.2 lbs (7.8 kgs) in air 5.1 lbs (2.32 kgs) in sea water, with batteries
Mounting:	Industry standard collars on 22.5 inch (0.57 m) centers

COMMUNICATIONS

Type:	Serial FSK
Frequency:	26 Kilohertz
Data Rate:	2400 Bits/second

DEPTH MEASUREMENT

Operating Range:	0 to 400 feet (122 m)
Resolution:	± 0.5 feet (0.15 m)



DIVING PLANE

Lift:	35 lbs (15.9 kilograms) at 5 knots and 15 degree wing angle
Airfoil:	NACA 651-012 Airfoil section
Wing Span:	19 inches (48.3 cm)

BATTERY

Cells:	4 D cell Lithium
Life:	2000 Hrs. Typical operation

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Figure 14. Specifications for Model 5010 DigiBIRD streamer depth controller or "bird". See text for discussion.

Model 5011 Compass Bird — Specifications

PHYSICAL CHARACTERISTICS

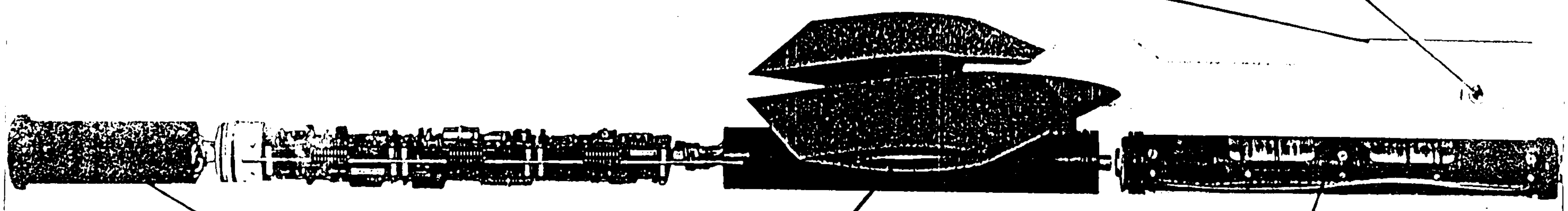
Length:	48.2 inches (1.2 m)
Weight:	18.3 lbs (8.32 kgs) in air 6.1 lbs (2.78 kgs) in sea water with batteries
Mounting:	Industry standard collars on 22.5 inch (0.57 m) centers

COMMUNICATIONS

Type:	Serial FSK
Frequency:	26 Kilohertz
Data Rate:	2400 Bits/second

DEPTH MEASUREMENT

Operating Range:	0 to 400 feet (122 m)
Resolution:	± 0.5 feet (0.15 m)



HEADING MEASUREMENT

Accuracy:	± 0.5 degrees
Resolution:	12 bits

DIVING PLANE

Lift:	35 lbs (15.9 kilograms) at 5 knots and 15 degree wing angle
Airfoil:	NACA 651-012 Airfoil section
Wing Span:	19 inches (48.3 cm)

BATTERY

Cells:	4 D cell Lithium
Life:	2000 Hrs. Typical operation

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Figure 15. Specifications for Model 5010 Compass Bird streamer depth controller or "bird". See text for discussion.

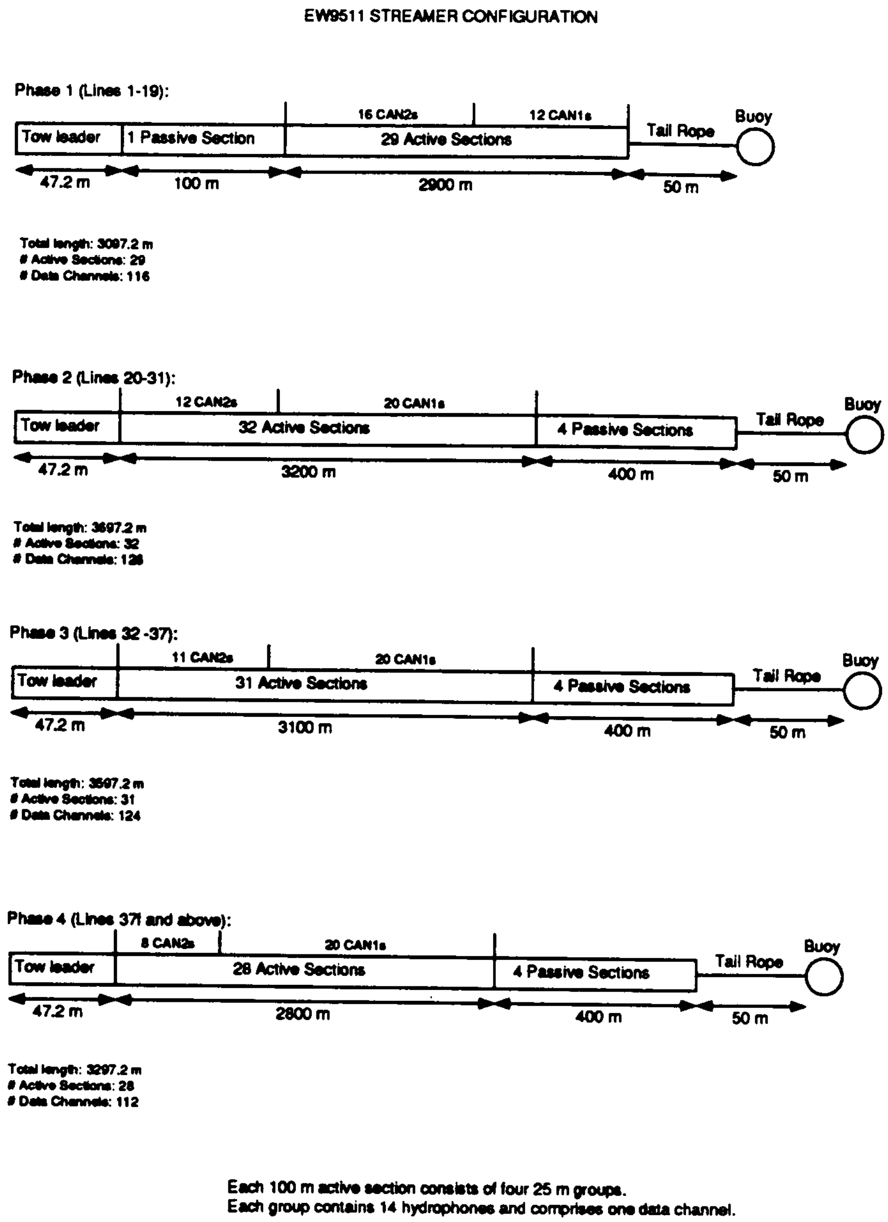

Figure 16. Summary of four different configurations of streamer used during EW95-11. Lines acquired during each of the four phases are indicated and shown in map view on Figures 17A-D. See text for discussion and description of streamer during EW95-10.

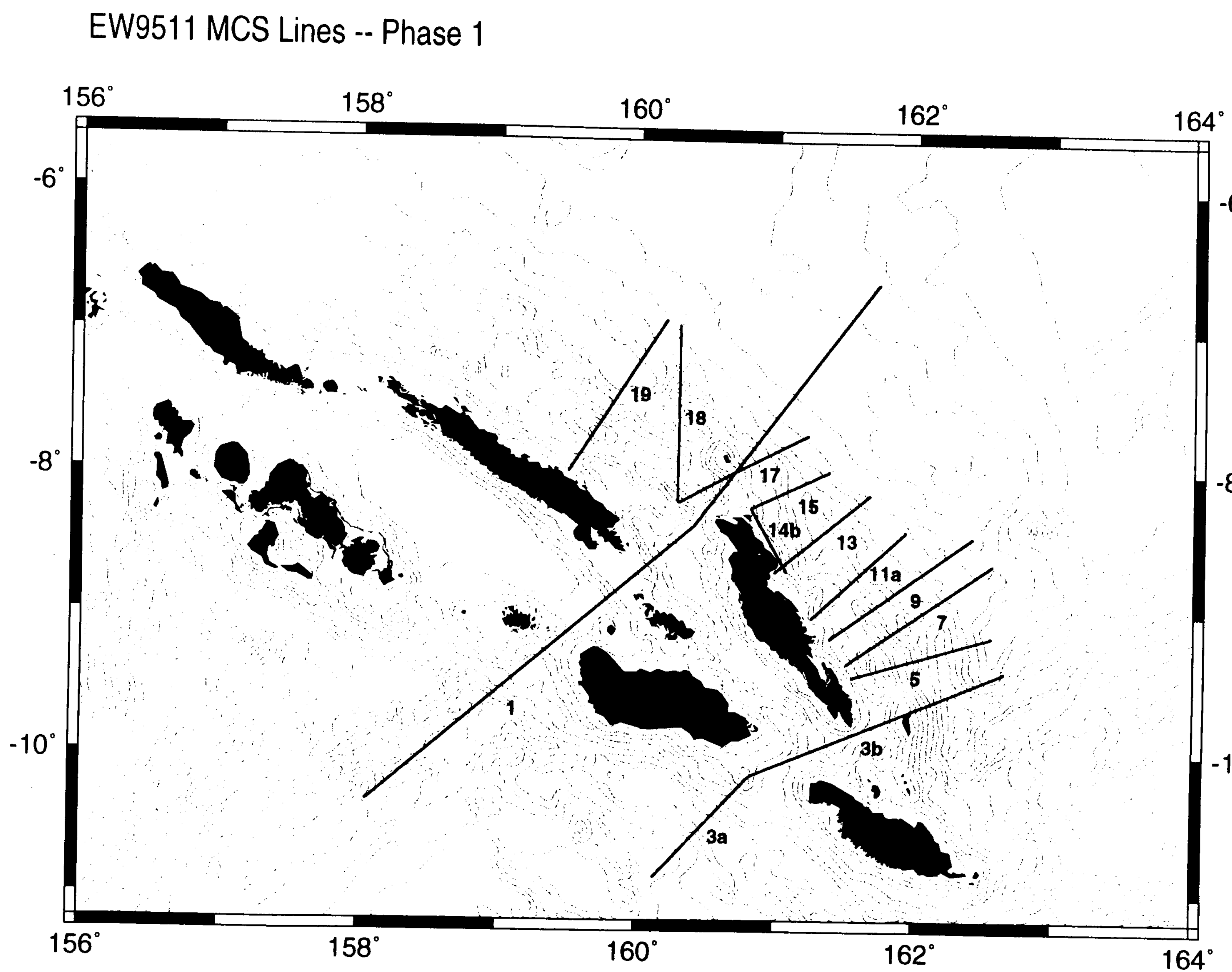

Figure 17A. Location map of MCS lines 1-19 collected during EW95-11 using the Phase 1 streamer configuration. See text for discussion and Figure 16 for specifications of Phase 1 streamer.

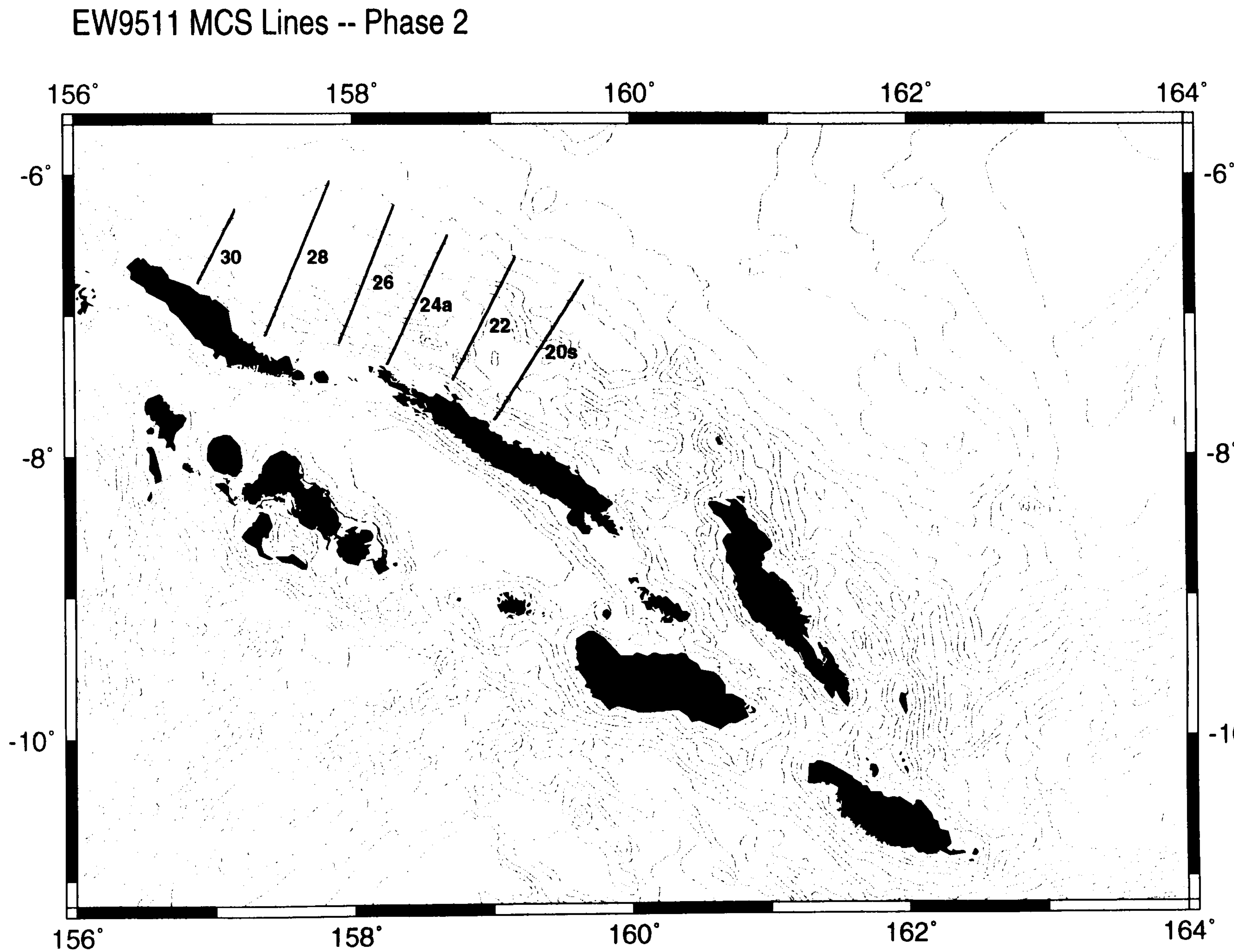

Figure 17B. Location map of MCS lines 20-30 collected during EW95-11 using the Phase 2 streamer configuration. See text for discussion and Figure 16 for specifications of Phase 2 streamer.

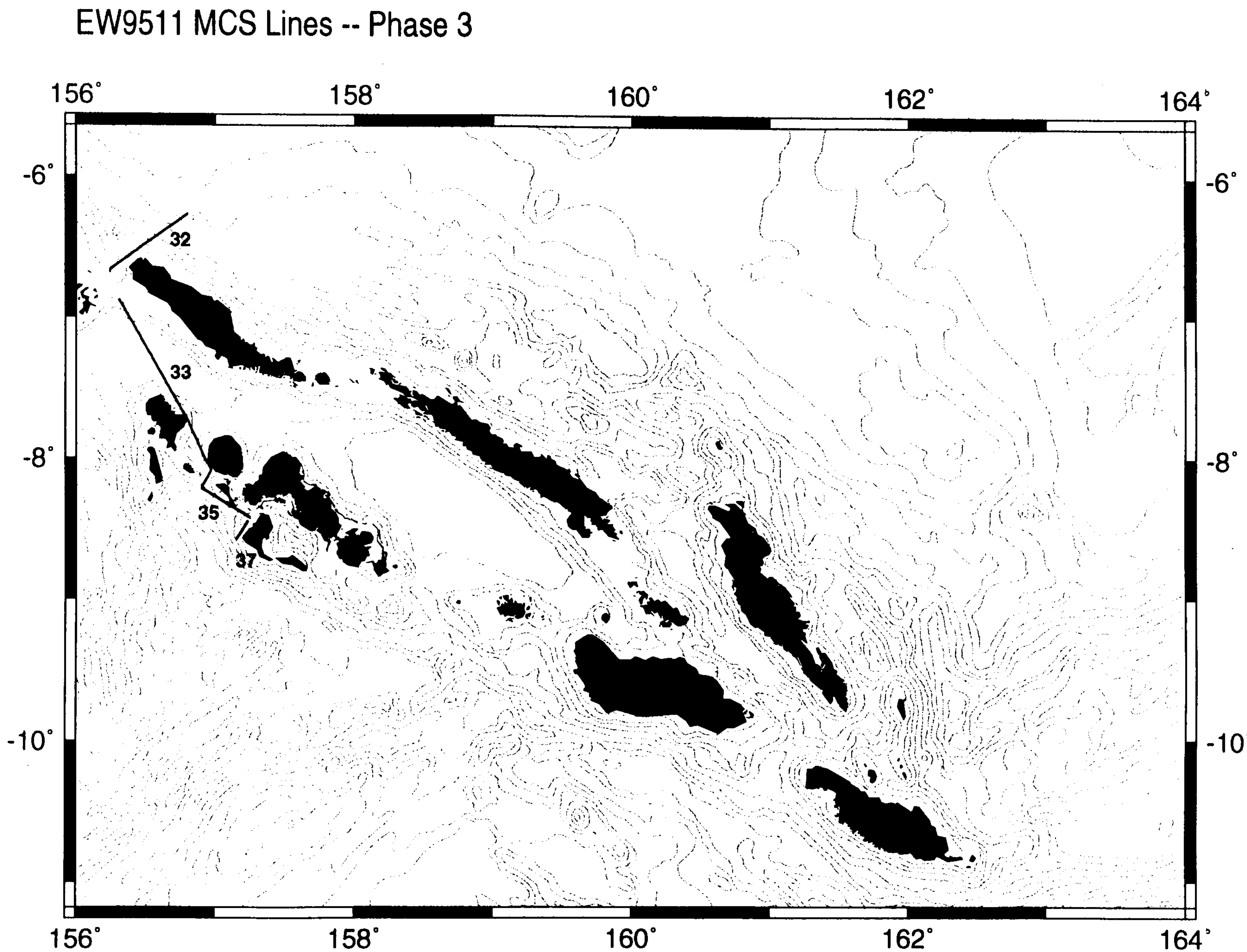

Figure 17C. Location map of MCS lines 32-37 collected during EW95-11 using the Phase 3 streamer configuration. See text for discussion and Figure 16 for specifications of Phase 3 streamer.

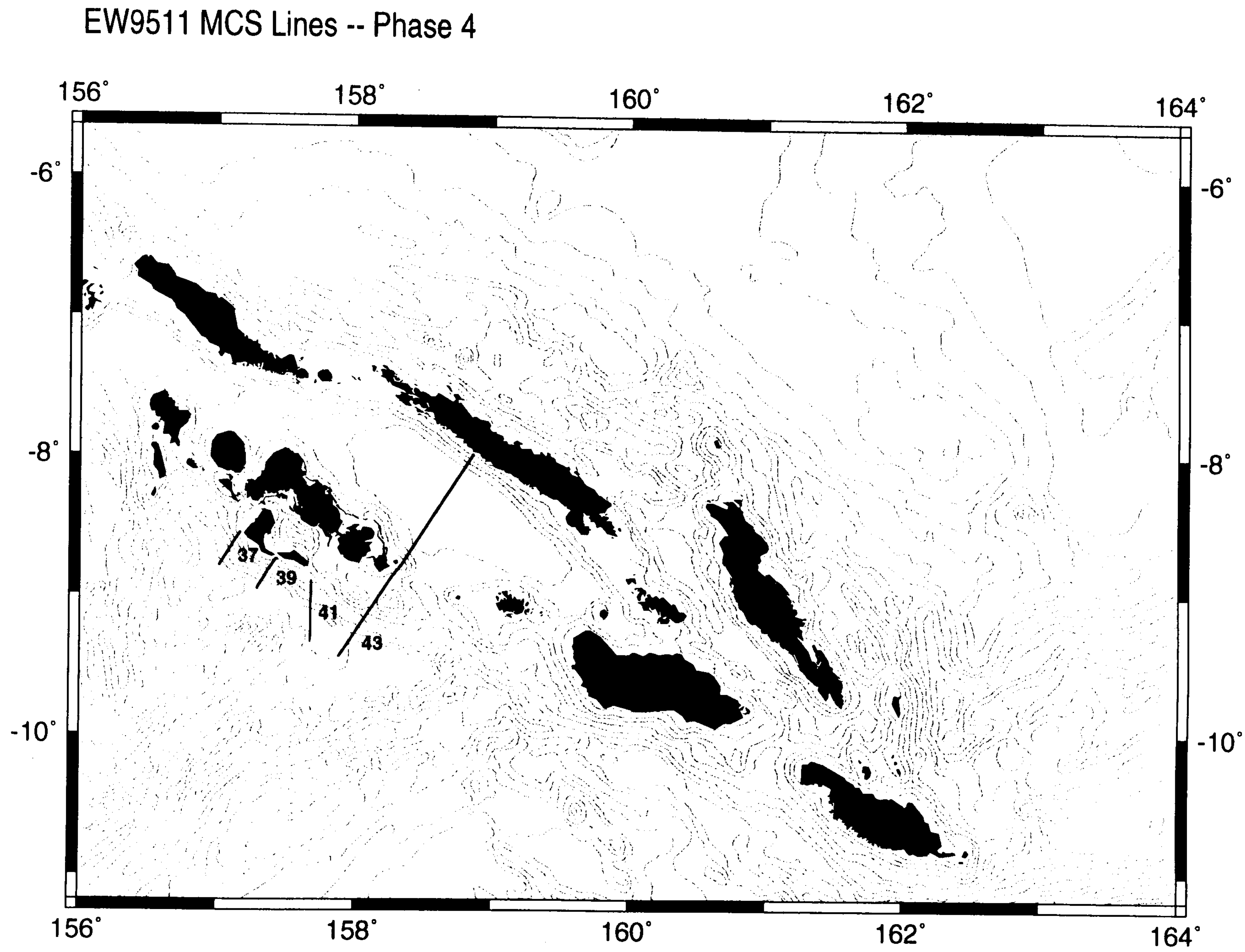

Figure 17D. Location map of MCS lines 37-43 collected during EW95-11 using the Phase 4 streamer configuration. See text for discussion and Figure 16 for specifications of Phase 4 streamer.

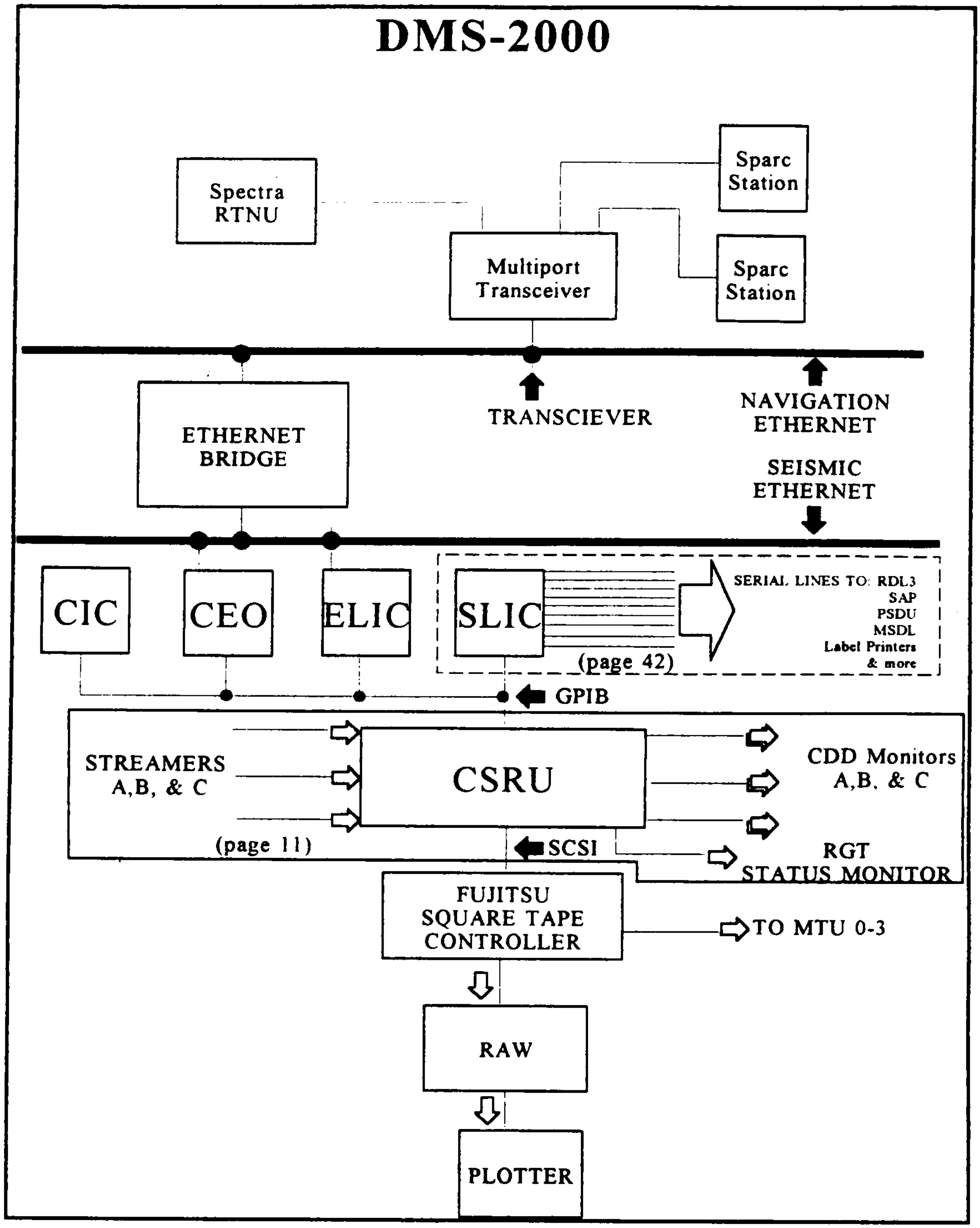

Figure 18. Schematic diagram of the DMS-2000 recording system. The Ewing is equipped with the newer DSS-240 system. Similarities between the two systems allows the use of this diagram for the description of the DSS-240.

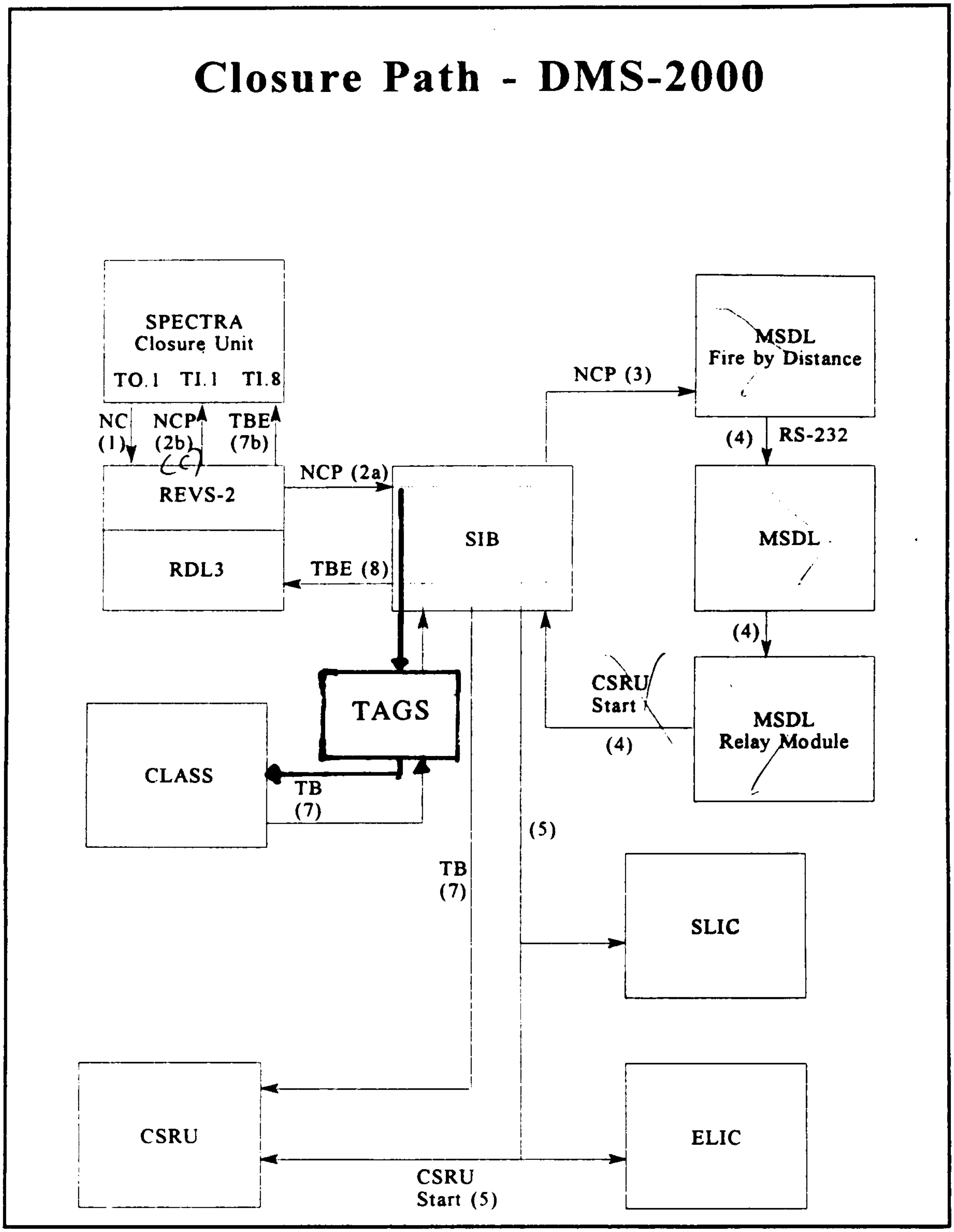

Figure 19. Shot cycle for the DSS-240. This figure was taken from the operations manual of the DMS-2000 which utilizes the MSDL subsystem. The DSS-240 uses the TAGS subsytem in place of MSDL.

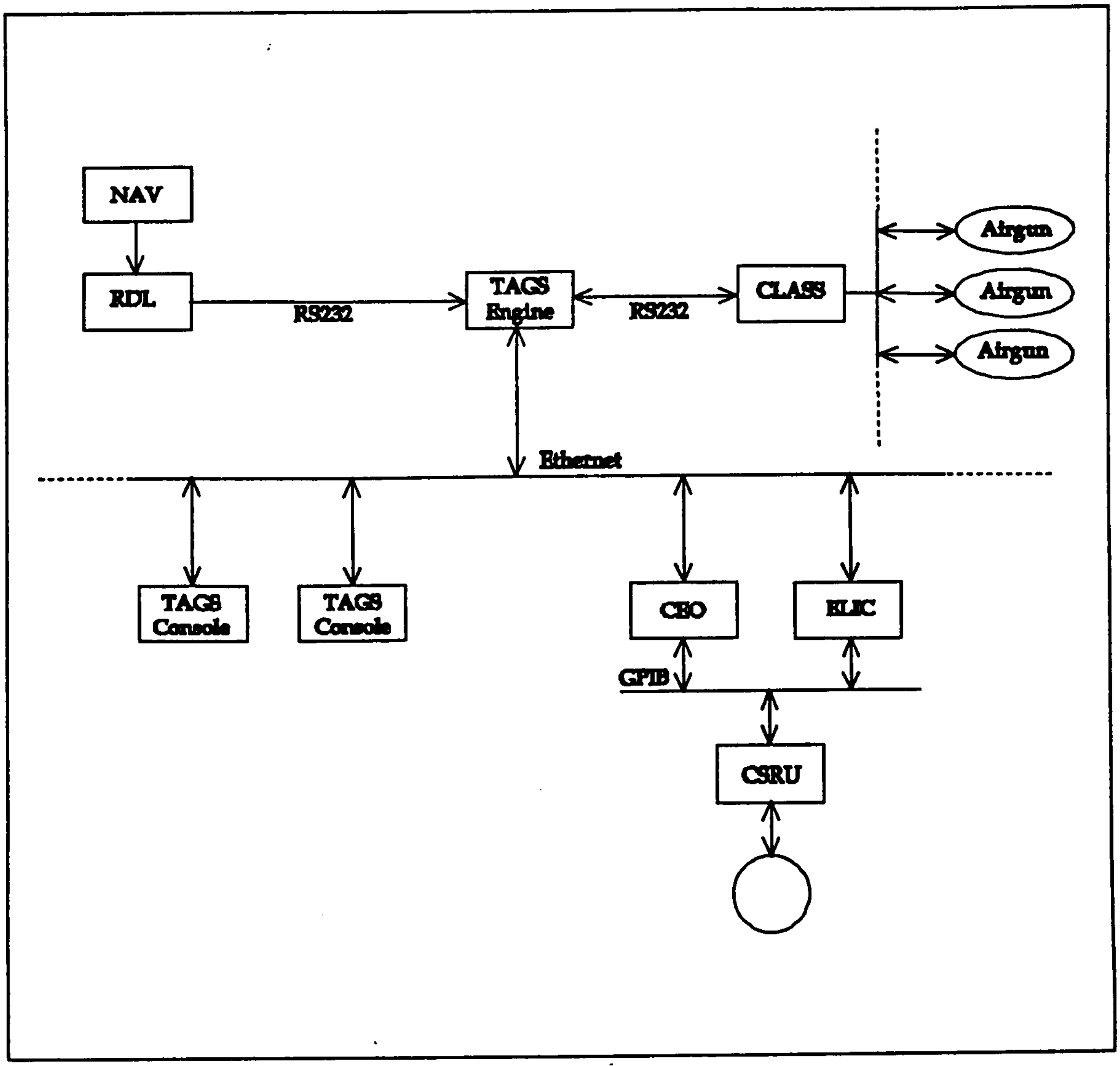

Figure 20. TAGS system integration and data flow for the DMS-2000. The DSS-240 has a similar data flow excepth that it does not receive the NC closure from navigation.

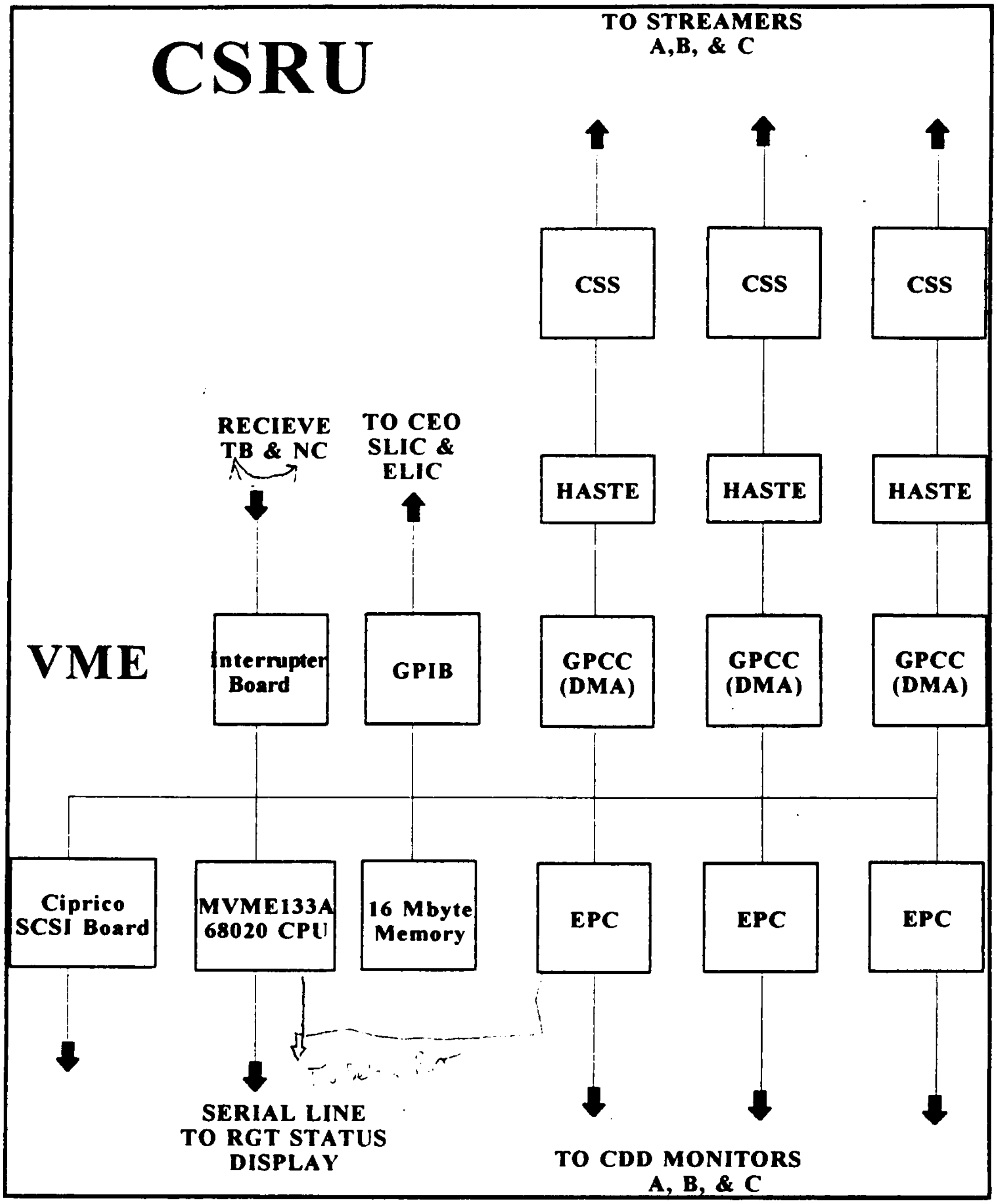

Figure 21. Cable Supervisor and Recording Unit for the DMS-2000. The DSS-240 utilizes a comparable scheme of subsystems.

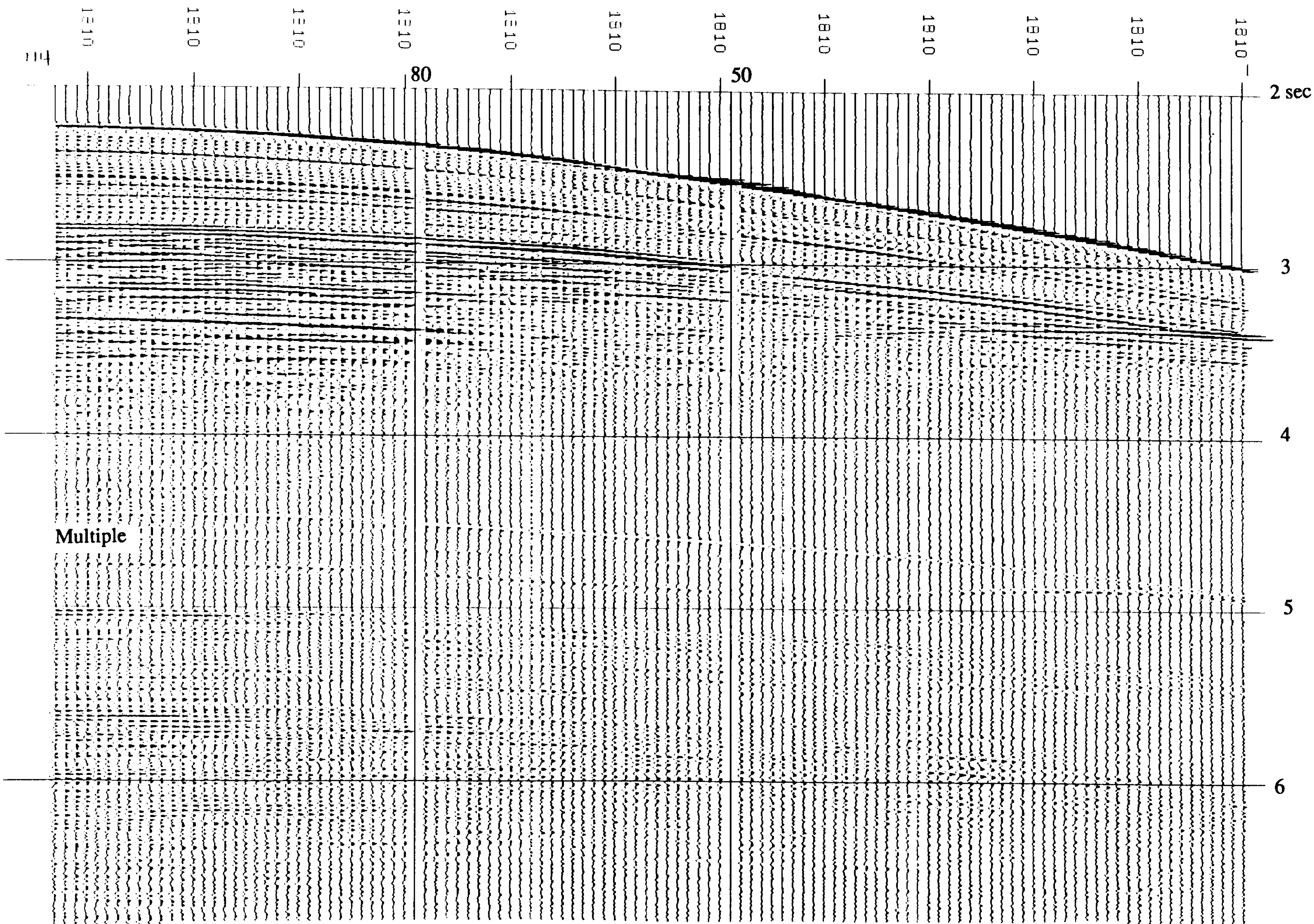

Figure 22. Gather of shot 1810 from EW95-11 MCS Line 1. Note the position of the water bottom multiple near 4.5 seconds.

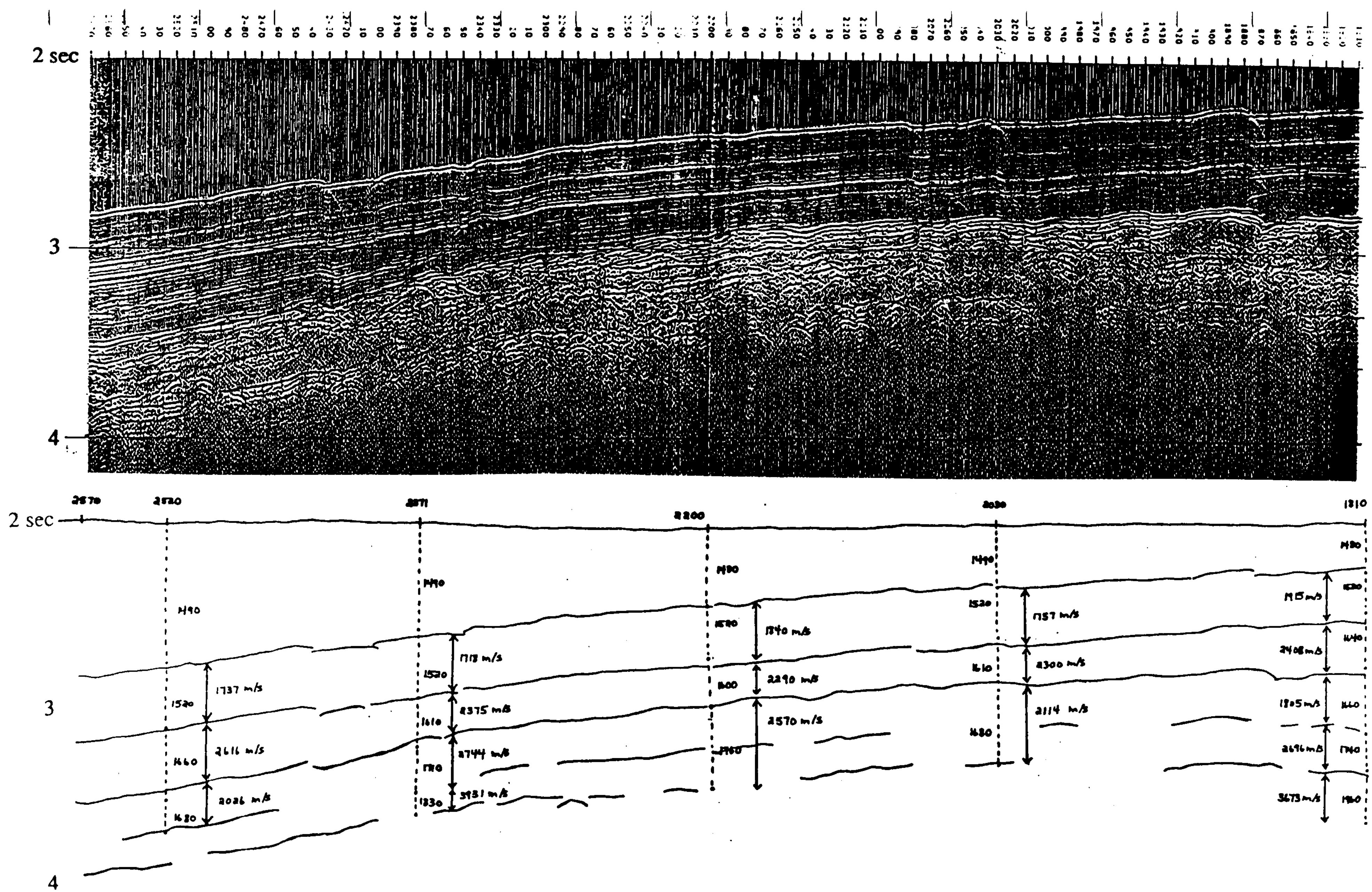

Figure 23A. Near trace plot along section part of EW95-11 Line 1 crossing the outer slope bulge of the Ontong Java Plateau (northeast to right of section). Continuous reflectors correspond to Upper Cretaceous-Cenozoic pelagic carbonate rocks capping the Cretaceous Ontong Java oceanic plateau. Igneous layering related to sills and flows in the upper part of the igneous basement makes the distinction between igneous basement and overlying sedimentary rocks problematic. Recent, high-angle faults may be related to plate flexure in outer slope area. **B.** Results of velocity analysis performed on the section shown in A. For each analysis, the RMS velocity is shown on the left and the interval velocity is on the right. Semblance peaks are indicated by small dots. Note the correspondence between these points and the interpreted reflectors. Velocities suggest that much of the layering seen in this area may be within the sedimentary cover of the plateau rather than from the oceanic plateau basement.

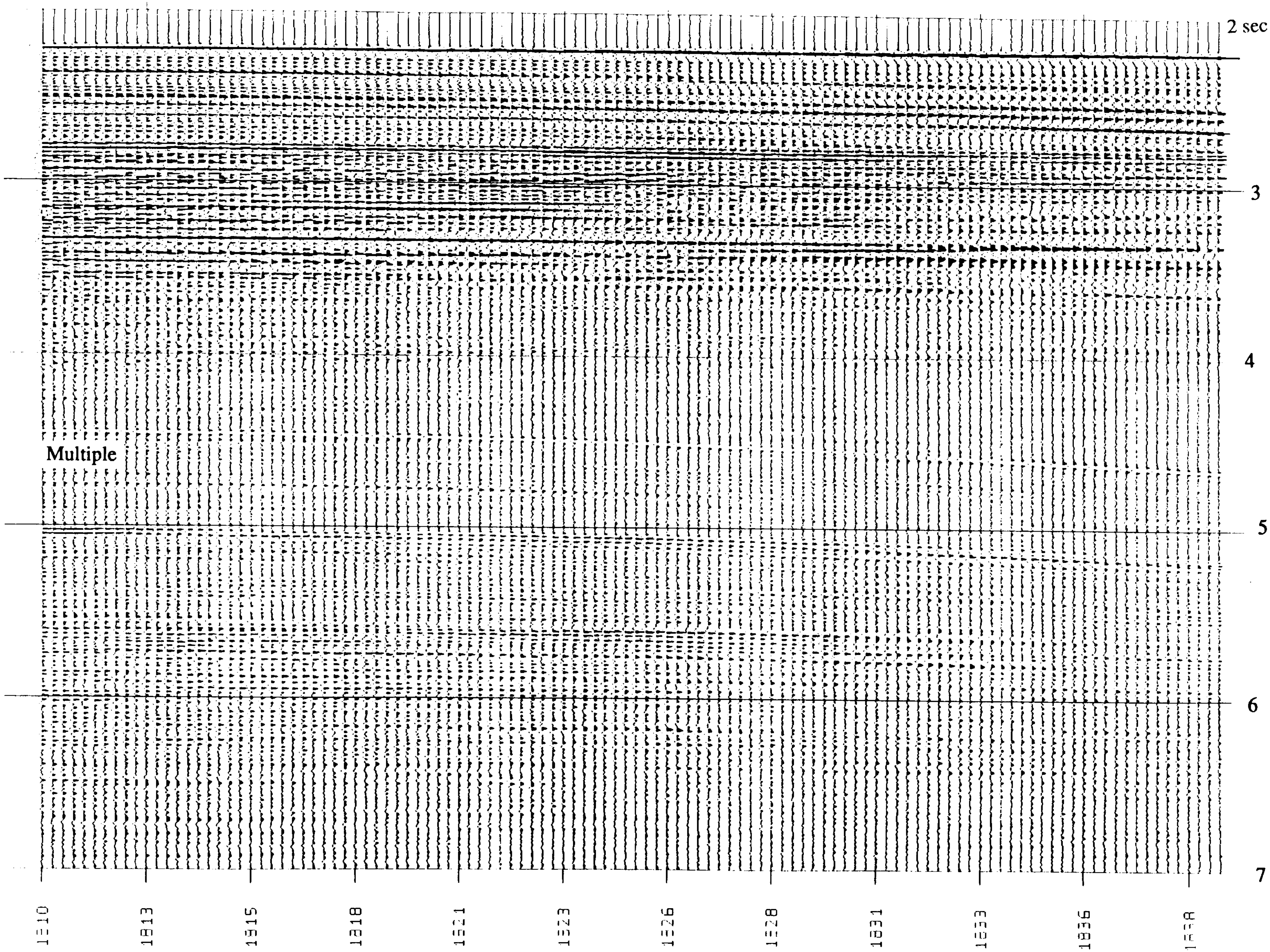

Figure 24. RP gather from EW95-11 MCS Line 1. The water bottom multiple aligns sub-horizontally in the near offset traces.

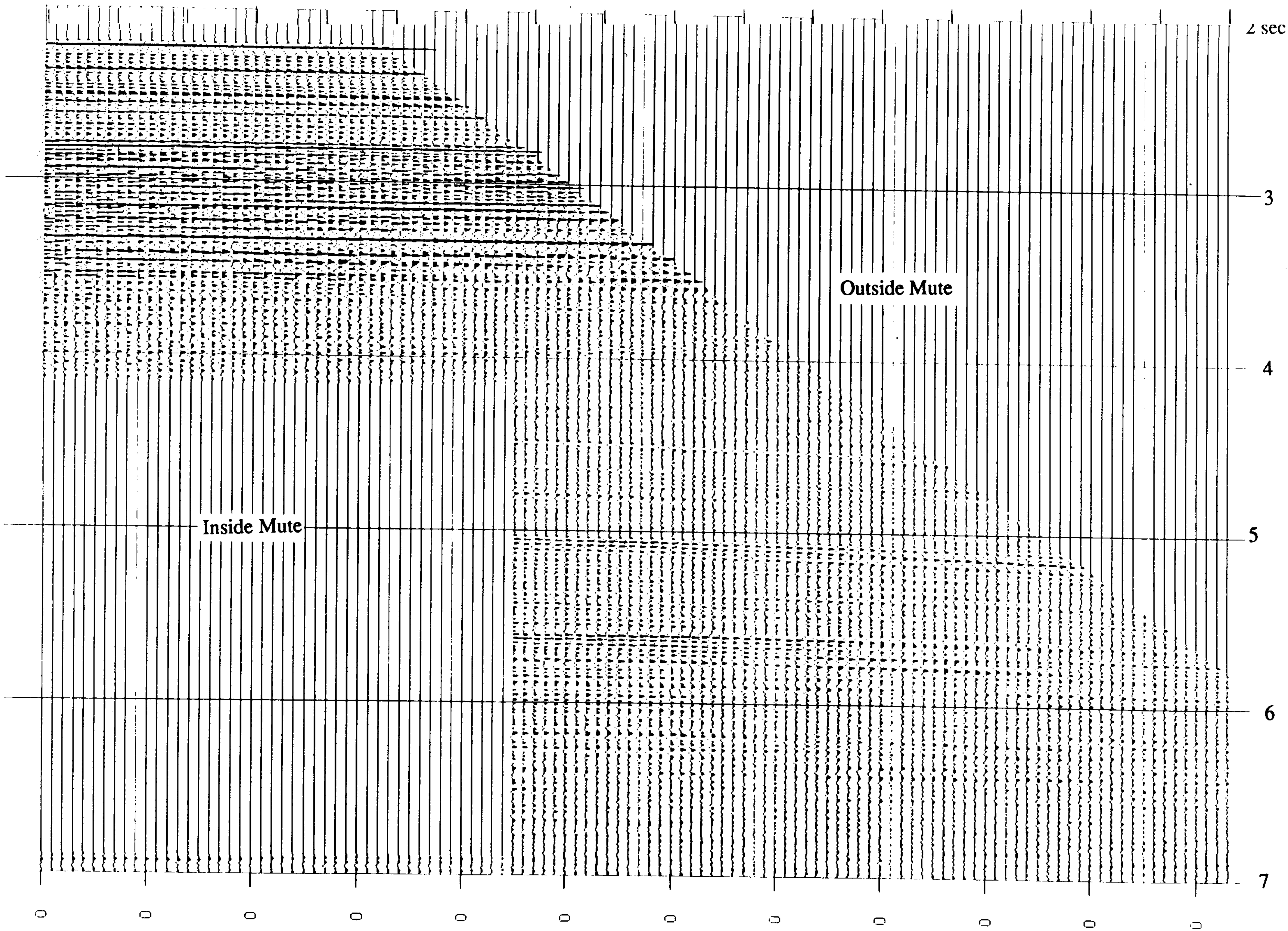

Figure 25. The same RP gather shown in Figure 24 after application of inside and outside mutes.

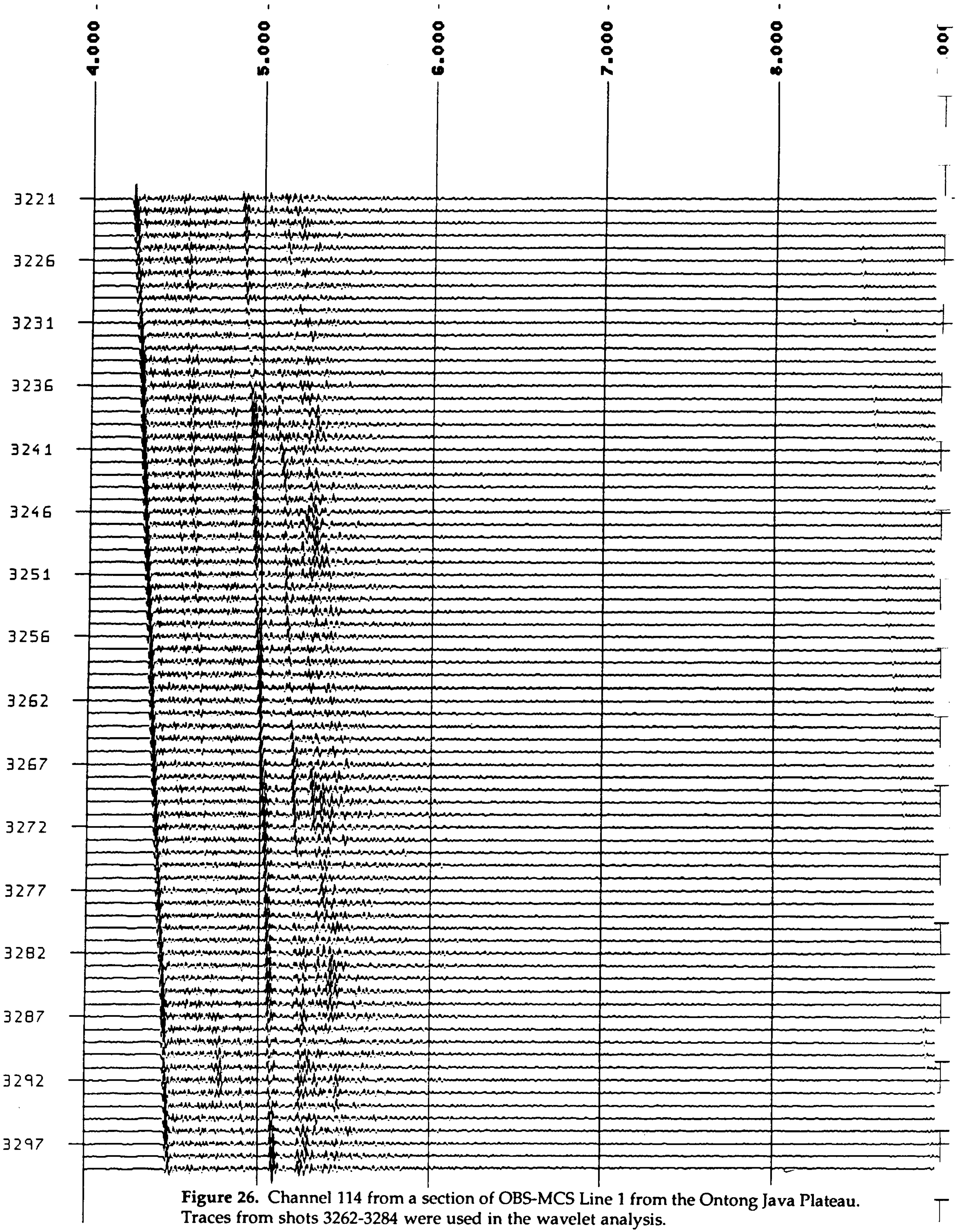

Figure 26. Channel 114 from a section of OBS-MCS Line 1 from the Ontong Java Plateau. Traces from shots 3262-3284 were used in the wavelet analysis.

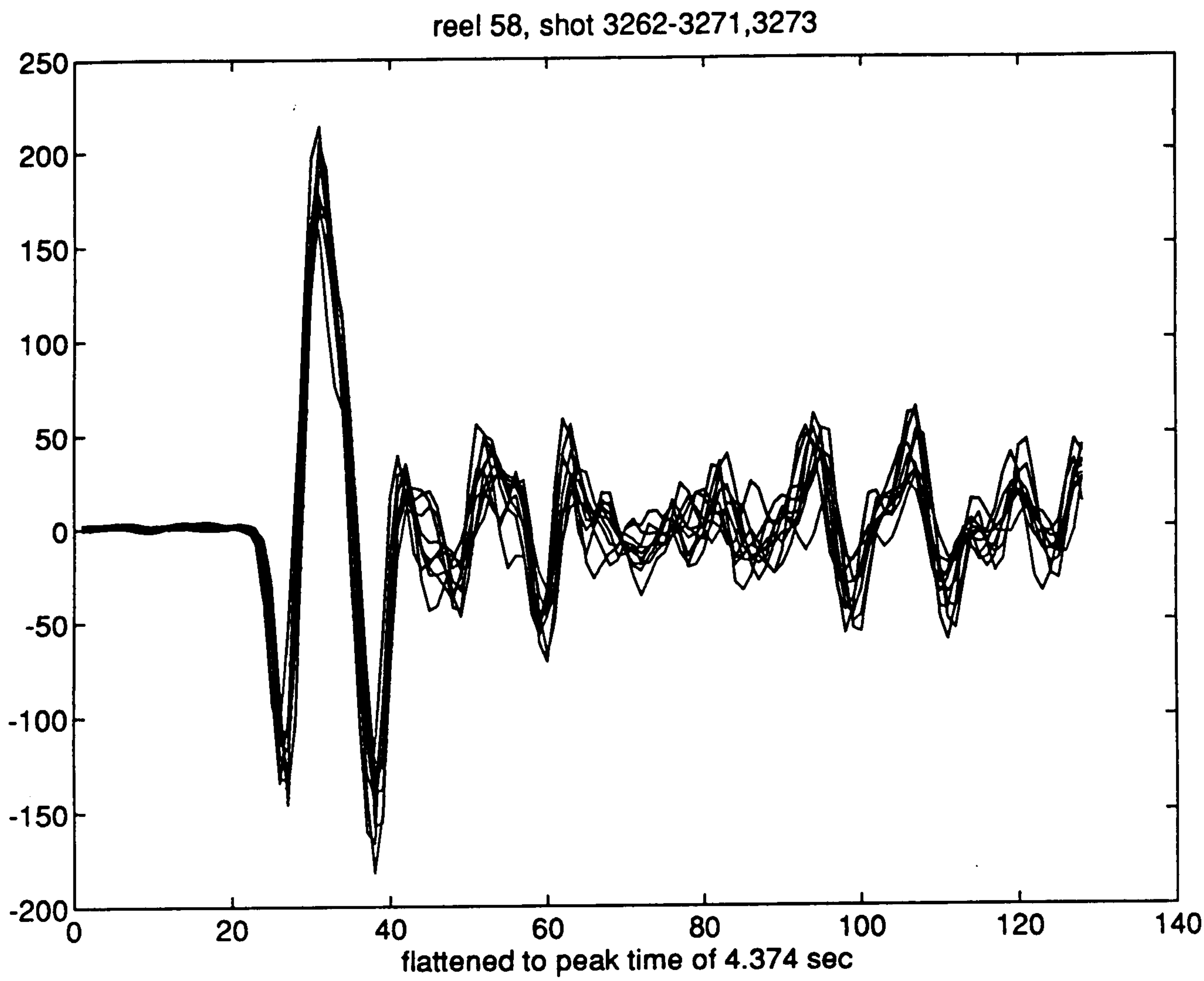

Figure 27. Traces from shots 3262-3271 and 3273 flattened on the peaks of the water bottom reflections to a peak time of 4.374 seconds for shot 3262. A 254 ms window including the full water bottom reflection waveform character is shown. The horizontal axis is labeled by number of time samples.

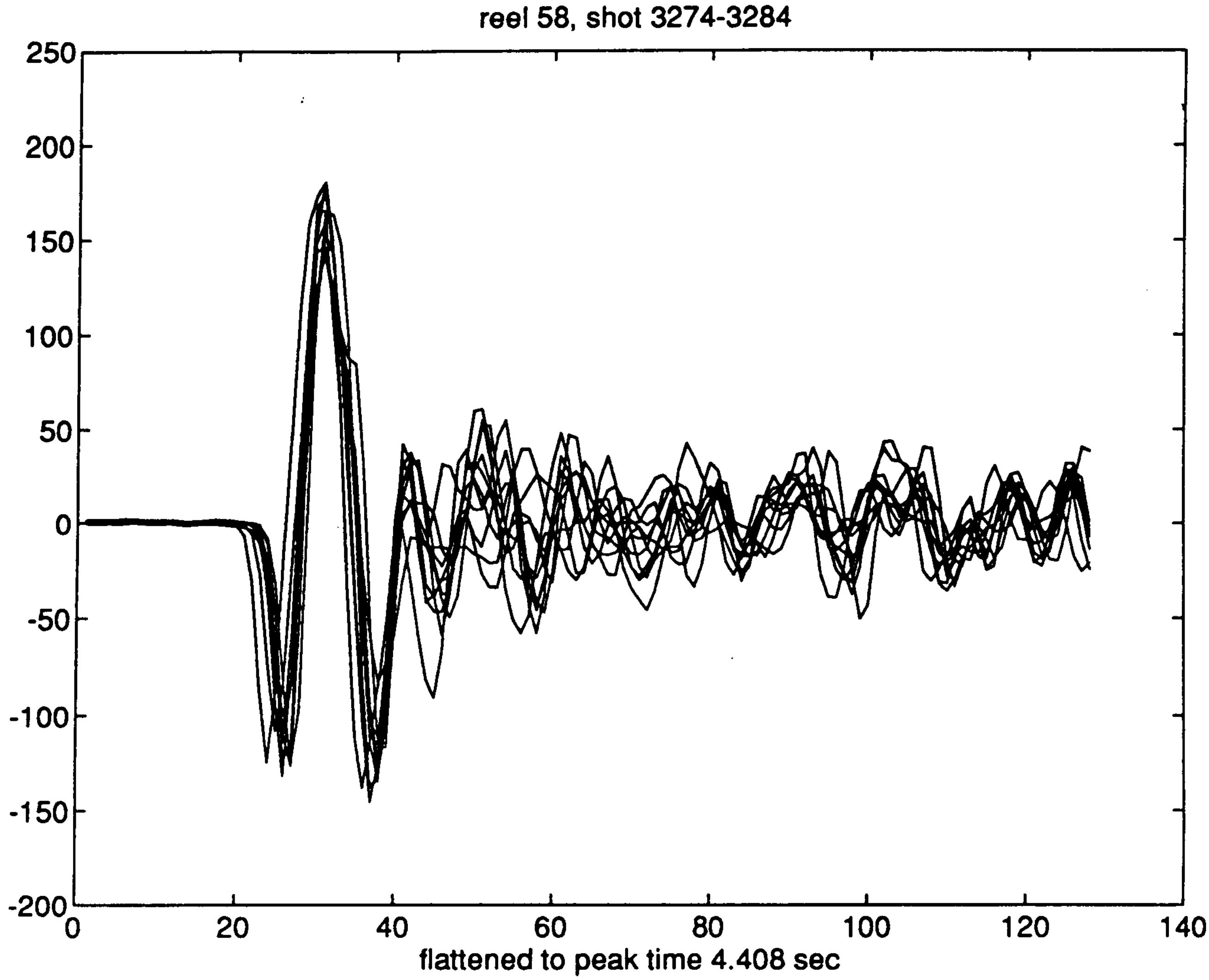

Figure 28. Traces from shots 3274-3284 and flattened on the peaks of the water bottom reflections to a peak time of 4.408 seconds for shot 3274. A 254 ms window including the full water bottom reflection waveform character is shown. The horizontal axis is labeled by number of time samples.

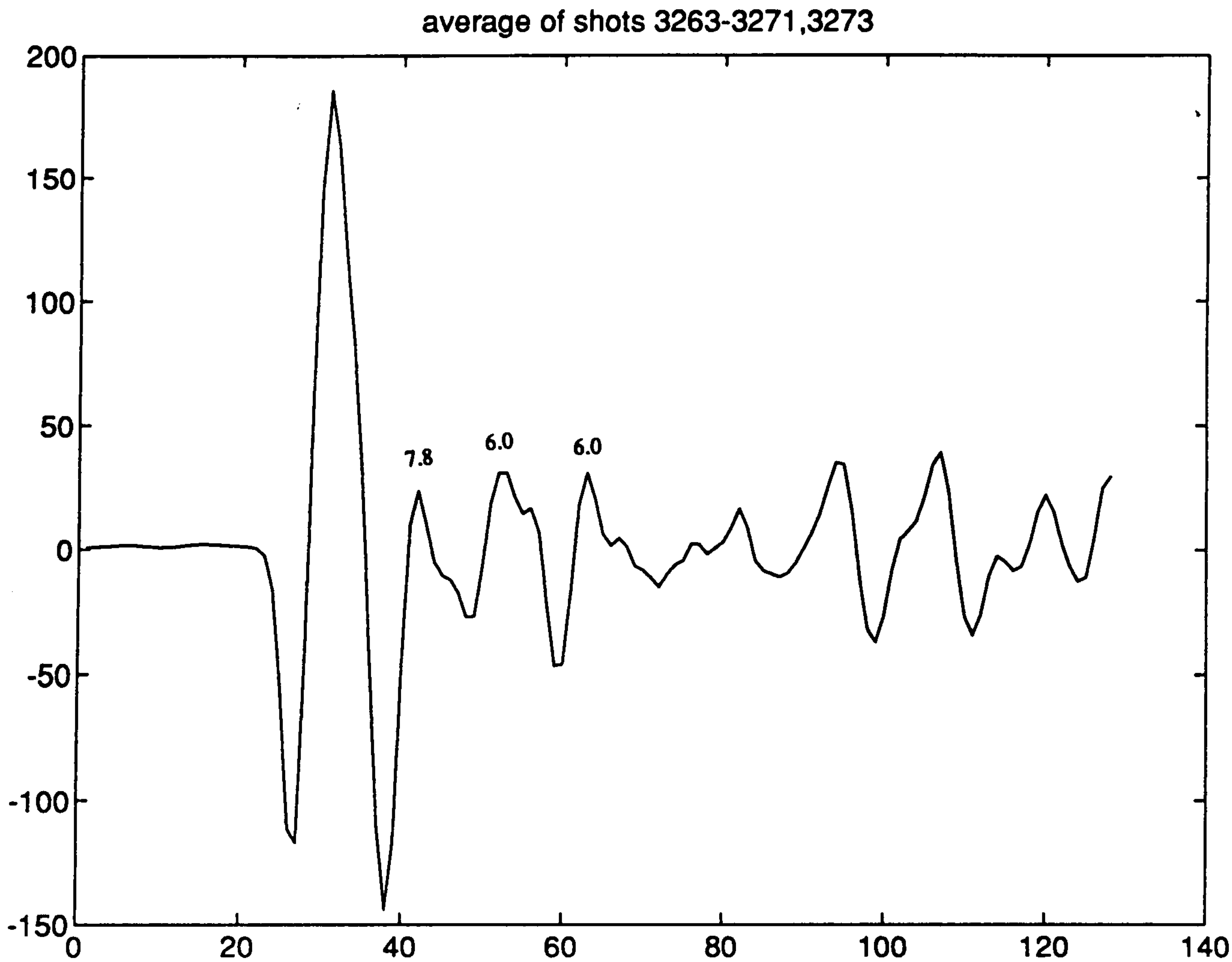

Figure 29. Average trace from flattened traces of shots 3262-3271 and 3273. Water bottom peak reflection time is 4.374 seconds. Horizontal axis is labeled by the number of time samples. Numbers above peaks of bubble pulses indicate peak to bubble ratios.

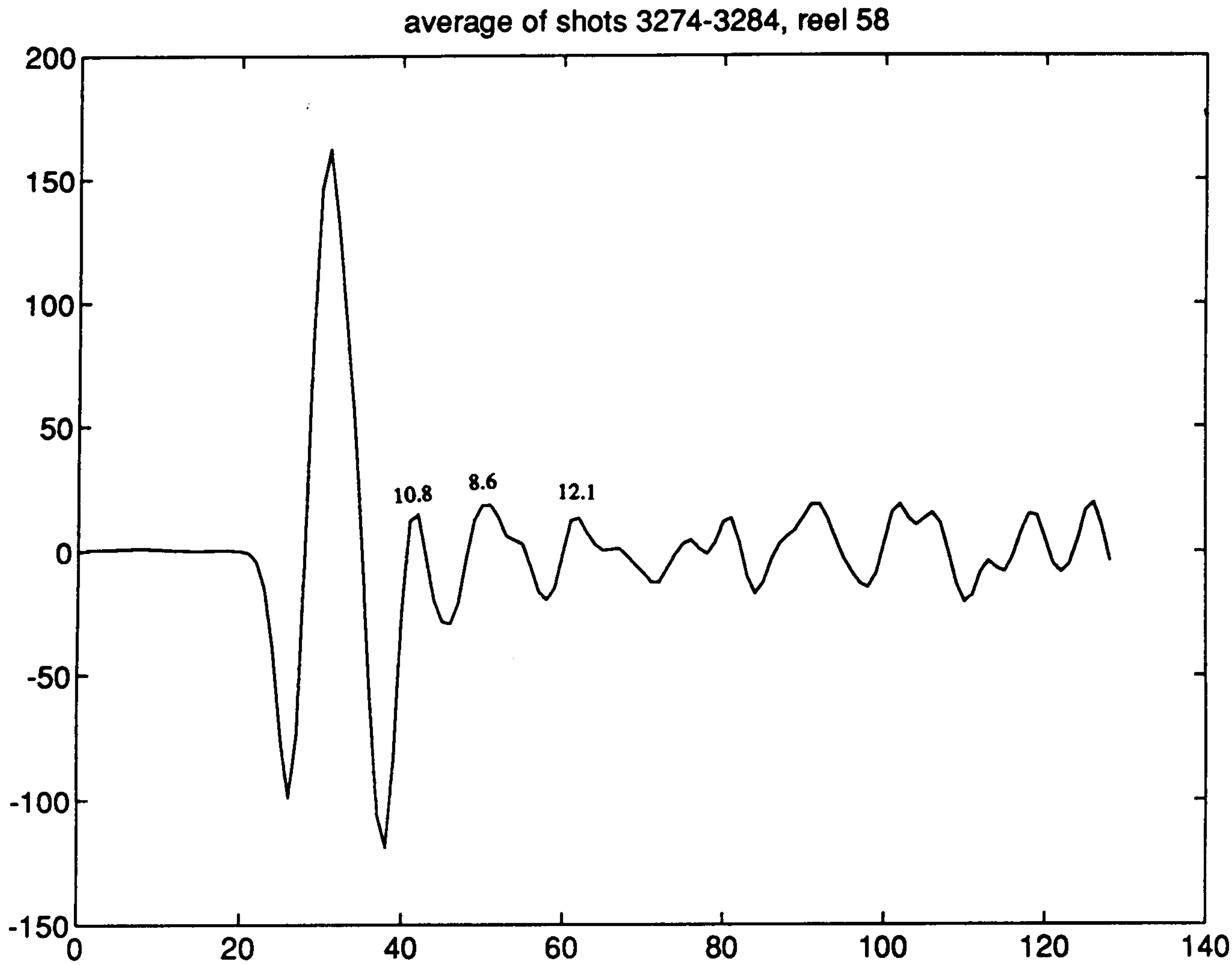

Figure 30. Average trace from flattened traces of shots 3274-3284. Water bottom peak reflection time is 4.374 seconds. Horizontal axis is labeled by the number of time samples. Numbers above peaks of bubble pulses indicate peak to bubble ratios.

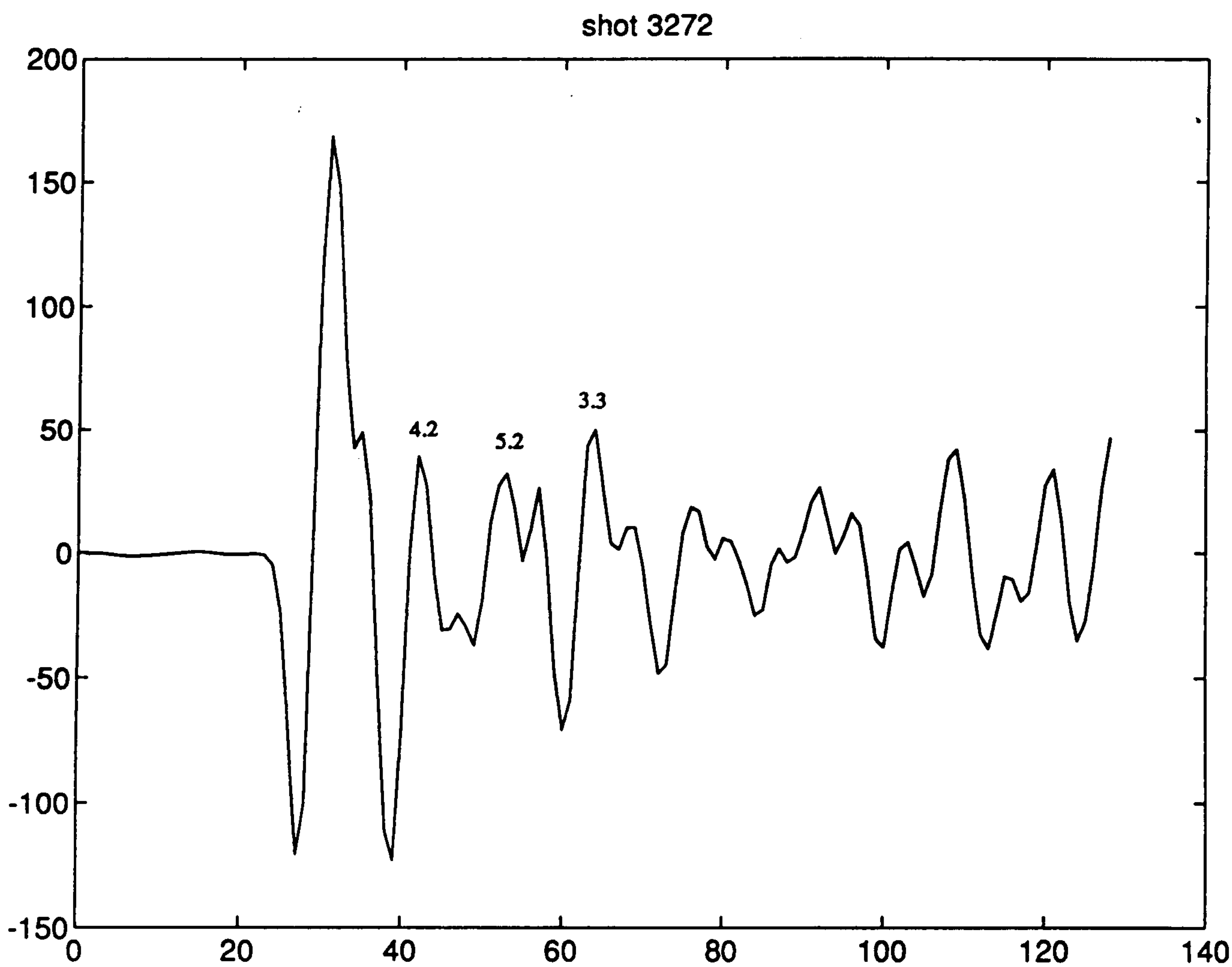

Figure 31. Trace from shot 3272. Water bottom peak reflection time is 4.400 seconds. Horizontal axis labeled by number of time samples. Numbers above peaks of bubble pulses indicate peak to bubble ratios.

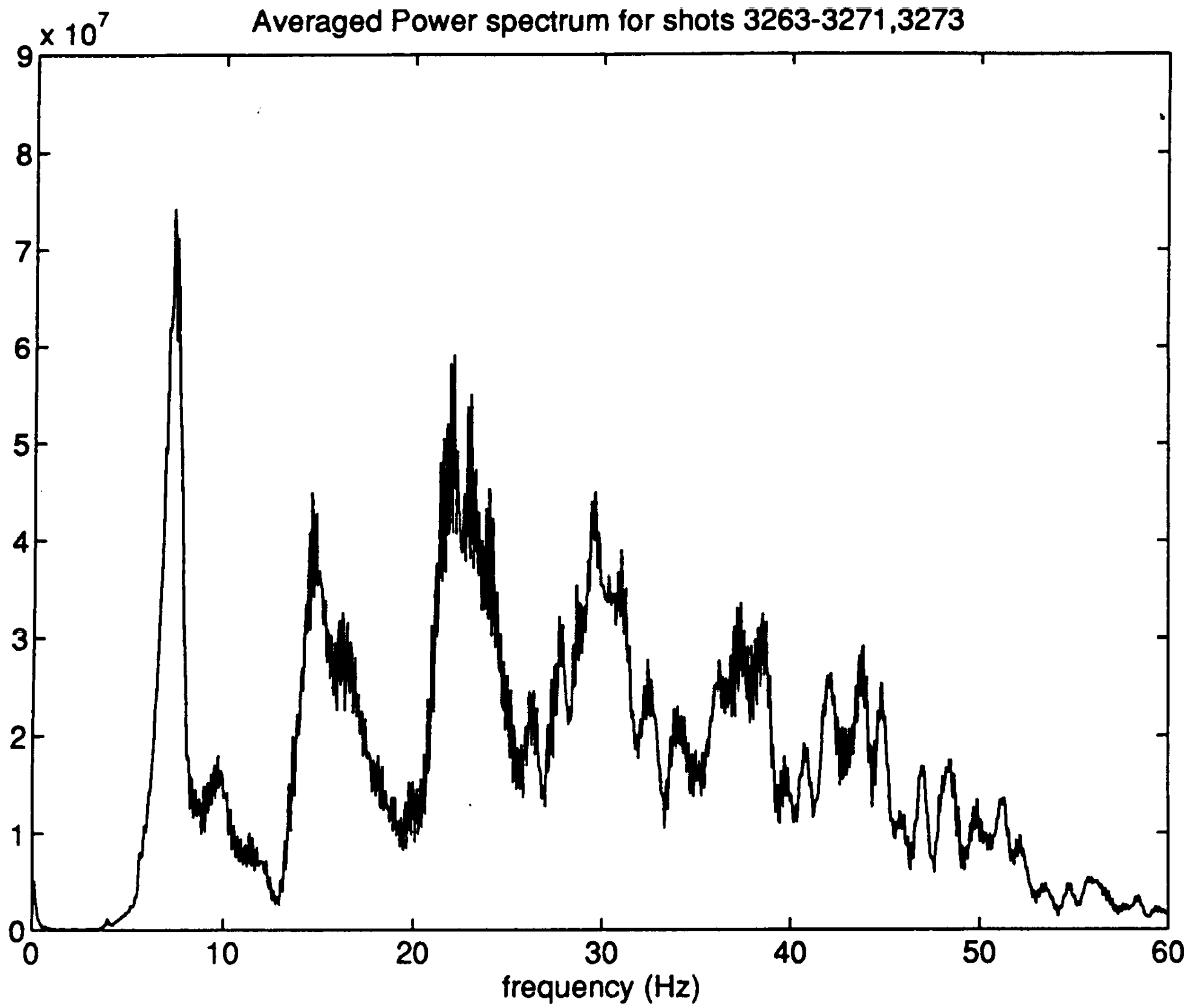

Figure 32. Averaged power spectrum for traces from shots 3262-3271 and 3273 (gun 17 was firing out-of-spec).

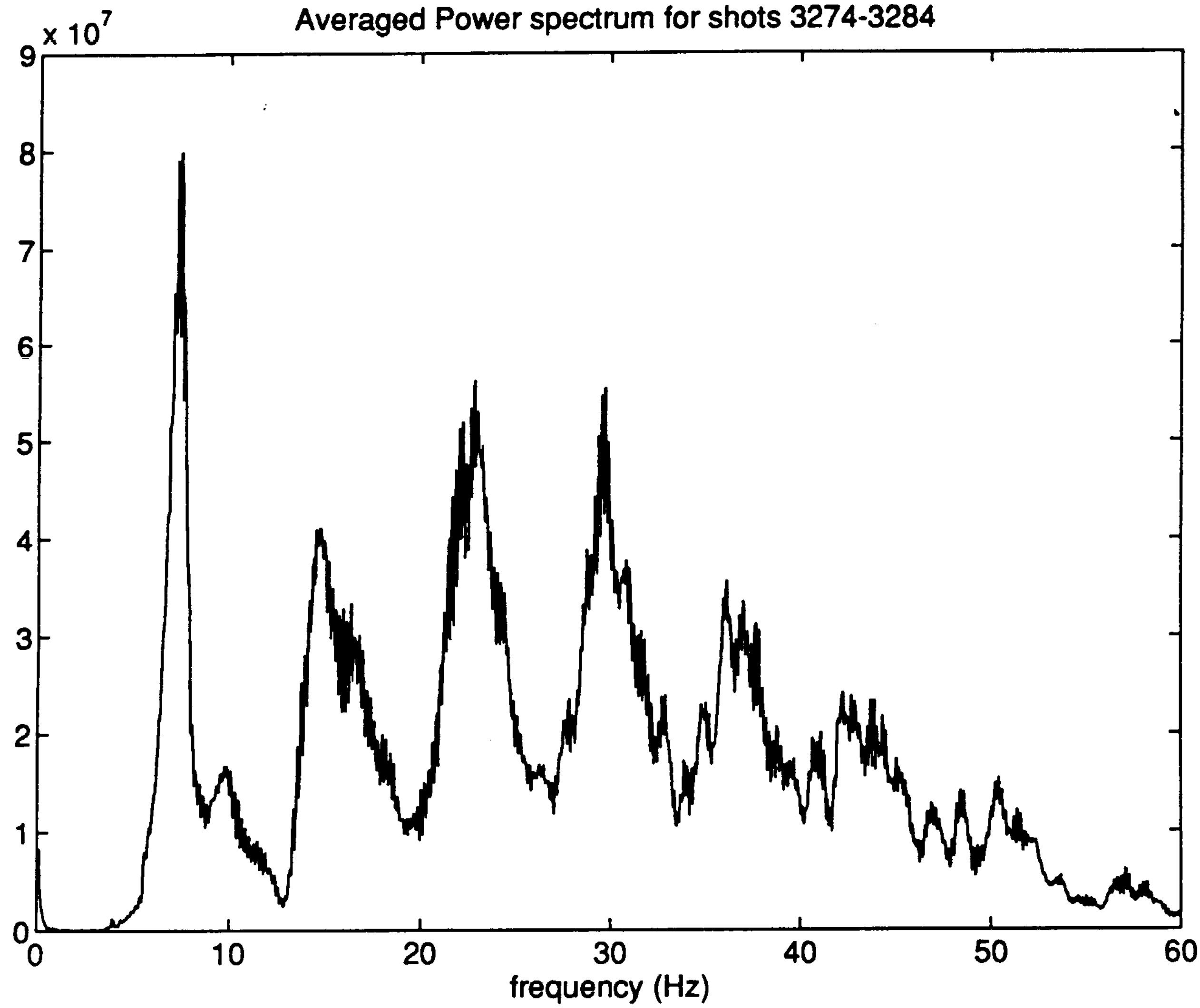

Figure 33. Averaged power spectrum for traces from shots 3274-3284 (all guns were firing in-spec).

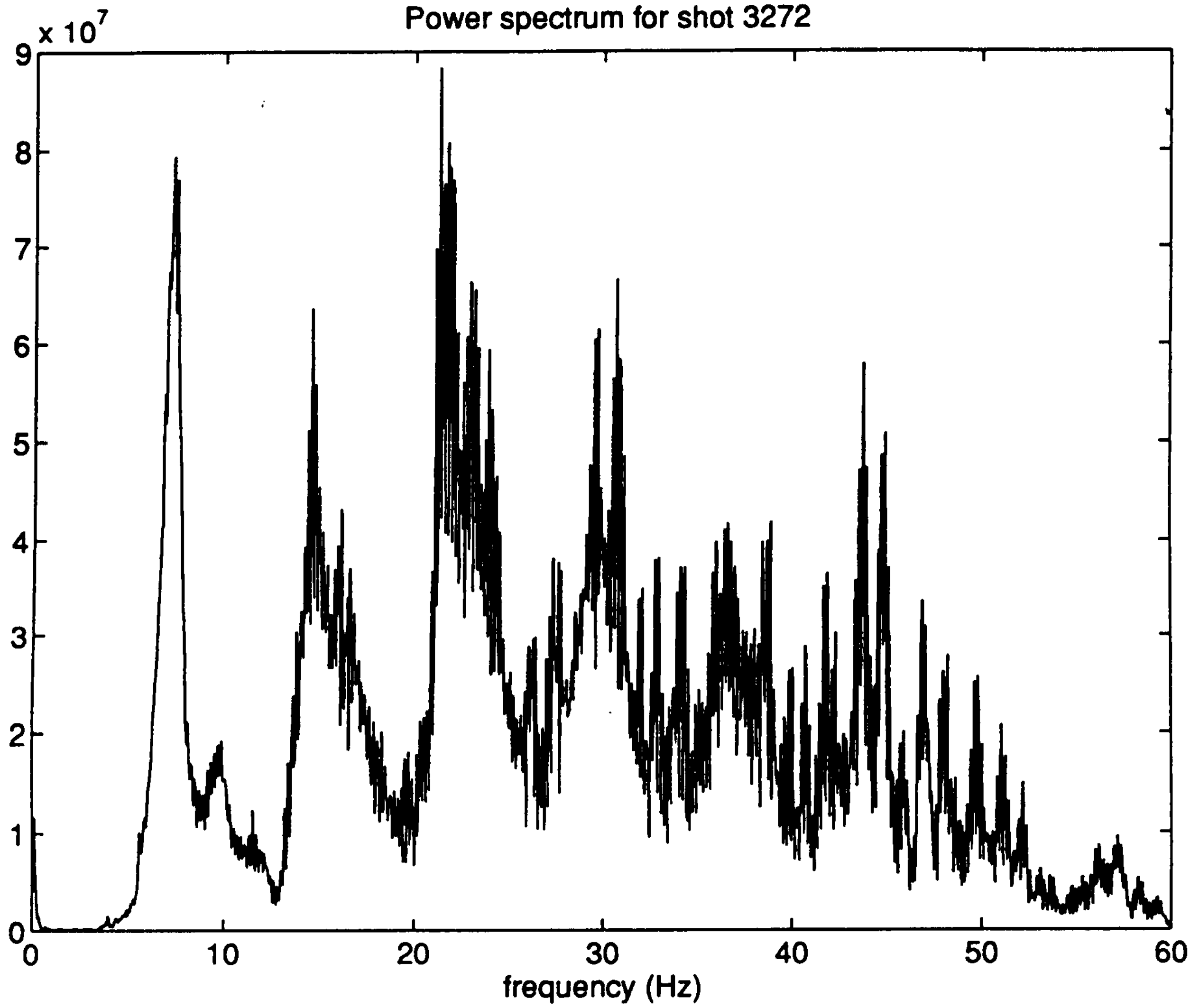

Figure 34. Power spectrum of trace from shot 3272 (1110in^3 gun firing out-of-spec).

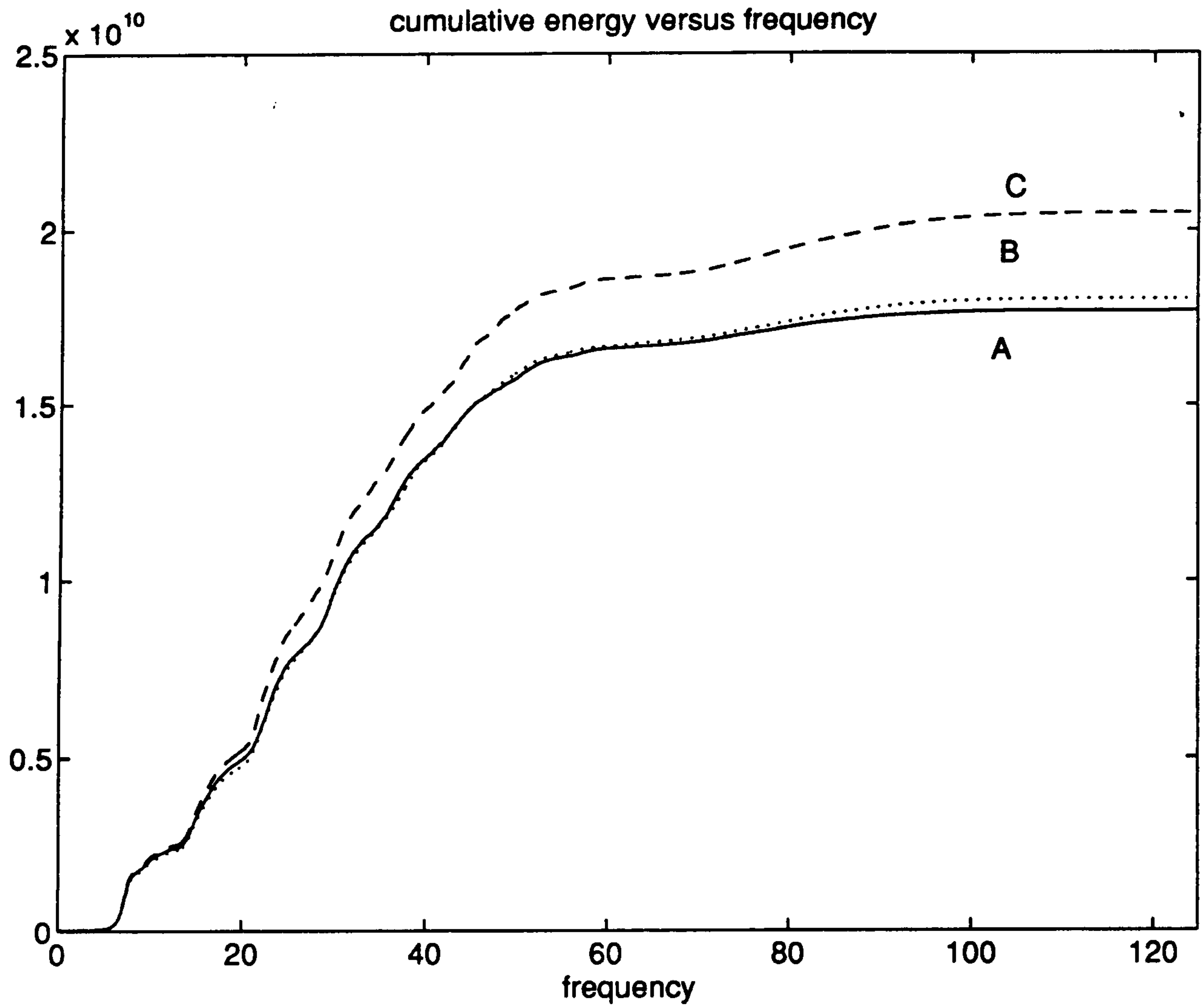

Figure 35. Comparison of cumulative energy versus frequency for power spectra shown in Figure 7 through Figure 9. A) all guns firing in-spec; B) gun 17 (260in^3) firing out-of spec; C) total volume of 1110 in^3 firing out-of spec.

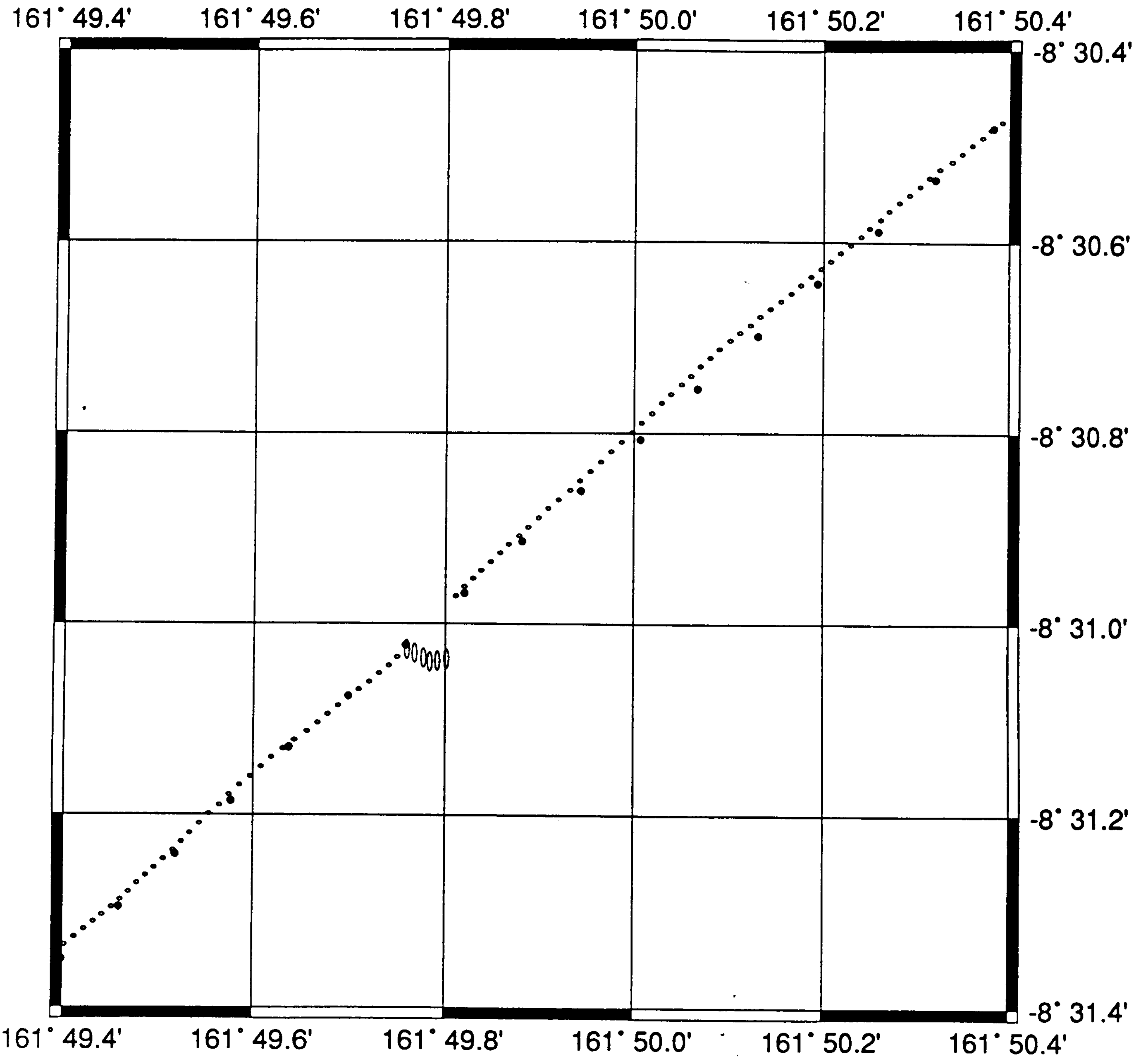

Figure 36. One minute plot of navigation for part of MCS line 11A collected during EW95-11. The open ellipses show GPS positions recorded directly onto the Navlog tape during data acquisition. The closed circles represent the best pick of various GPS and dead reckoning (DR) sources samples at a one minute interval. For this track and most EW95-11 tracks DR sources are unlikely because sufficent GPS satellites were visible for GPS-based navigation. At 8°31.05', 161°49.8', there is a large degree of error in the GPS-based position. The lengths of the ellipse axes in the latitude and longitude show NDOP and EDOP, respectively. DOP values have been normalized to DOP/50 inches. The large error is probably related to a change between visible GPS satellites used to calculate the position at this point.

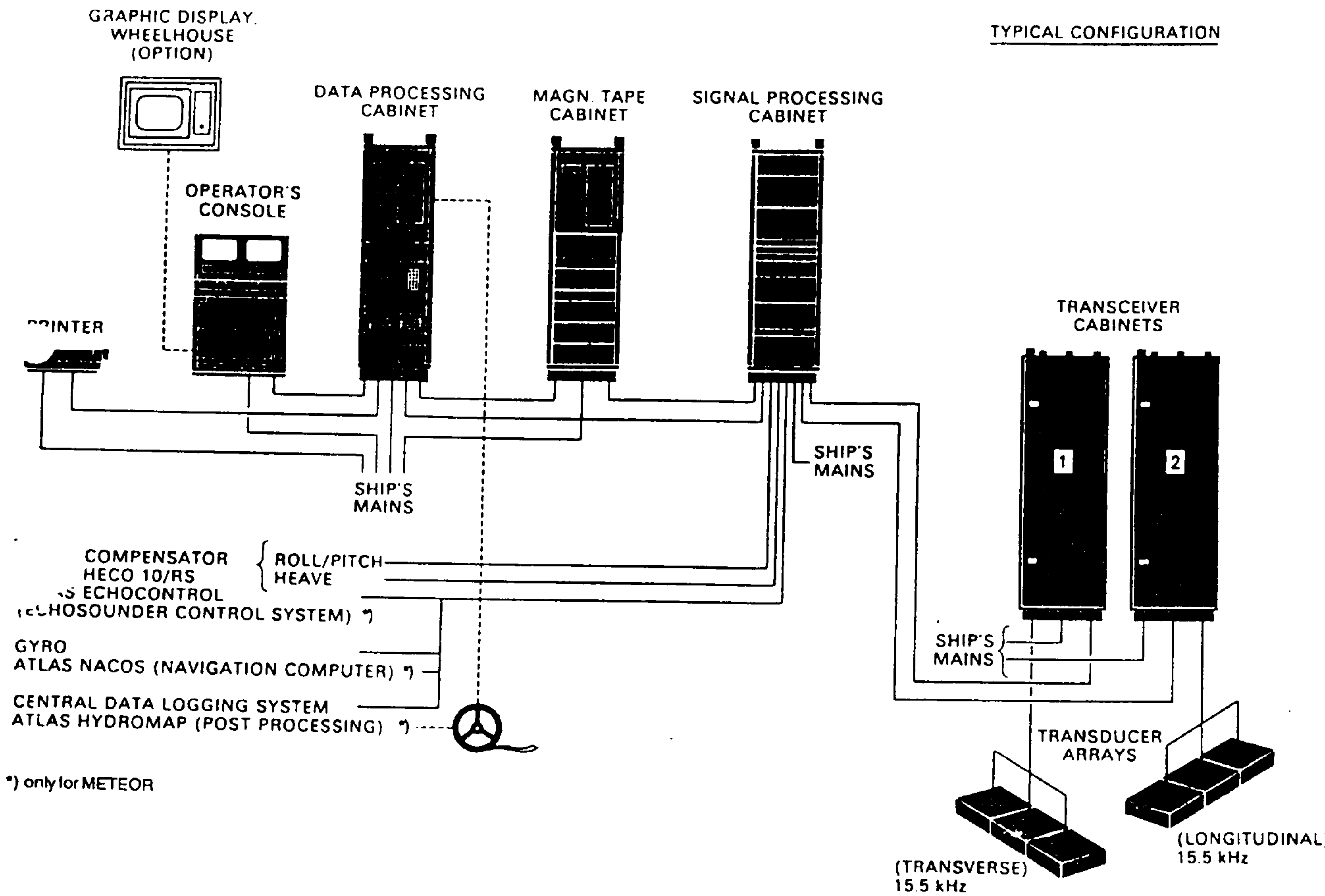

Figure 37. Hardware in science lab used to support Atlas Hydrosweep system.

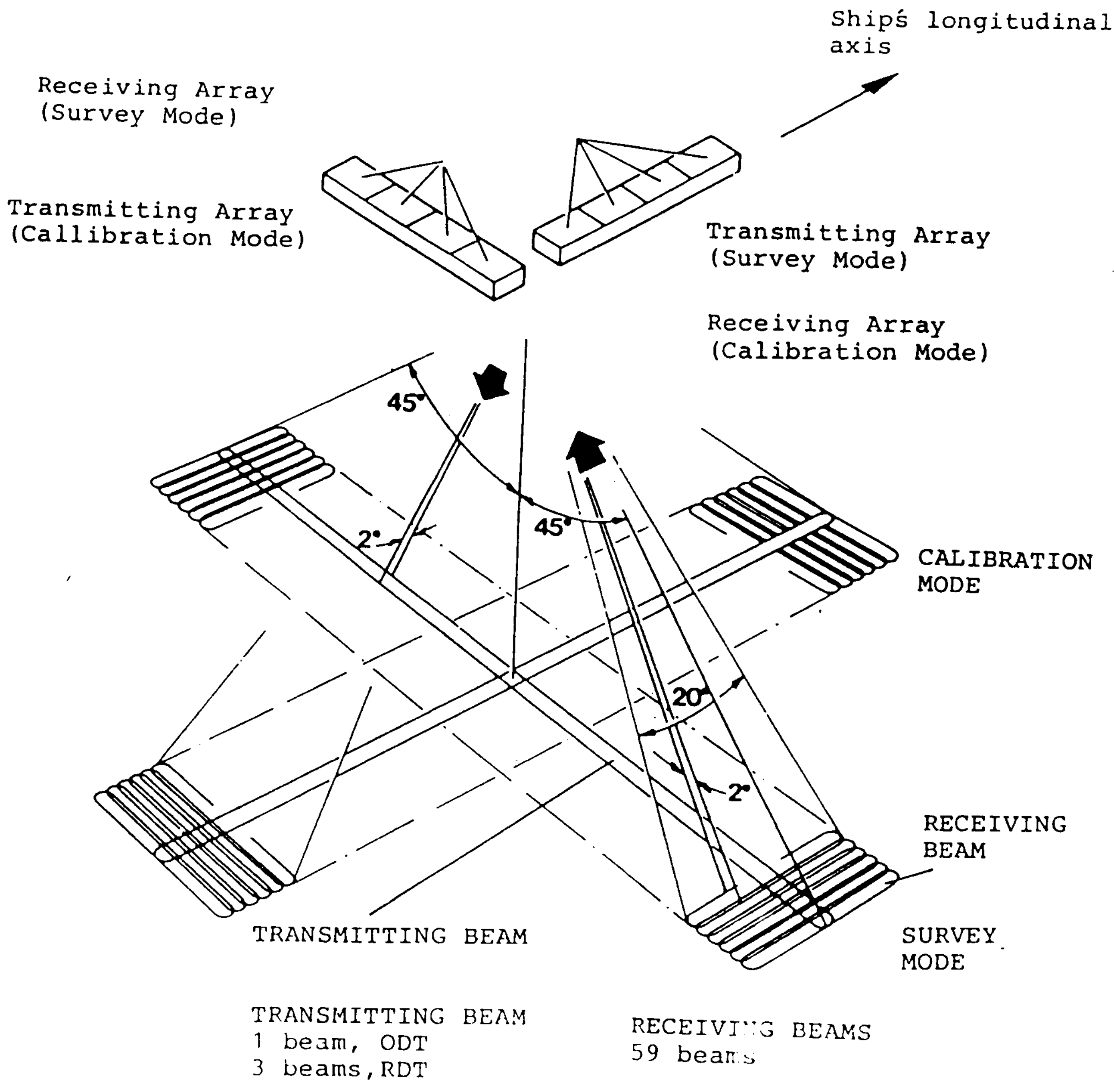

Figure 38. Beam configuration for Atlas multi-beam sweeping echosounder. See text for discussion.

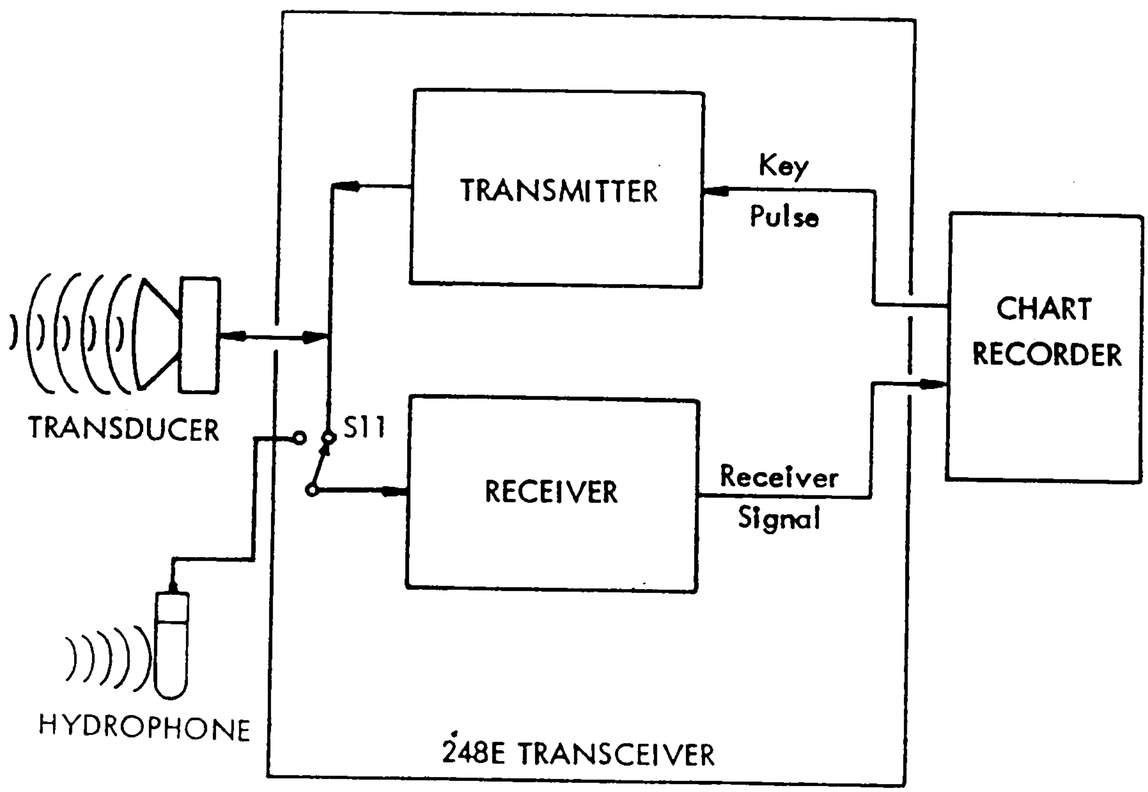

Figure 39. Block diagram showing components of 3.5 kHz sonar system. See text for discussion.

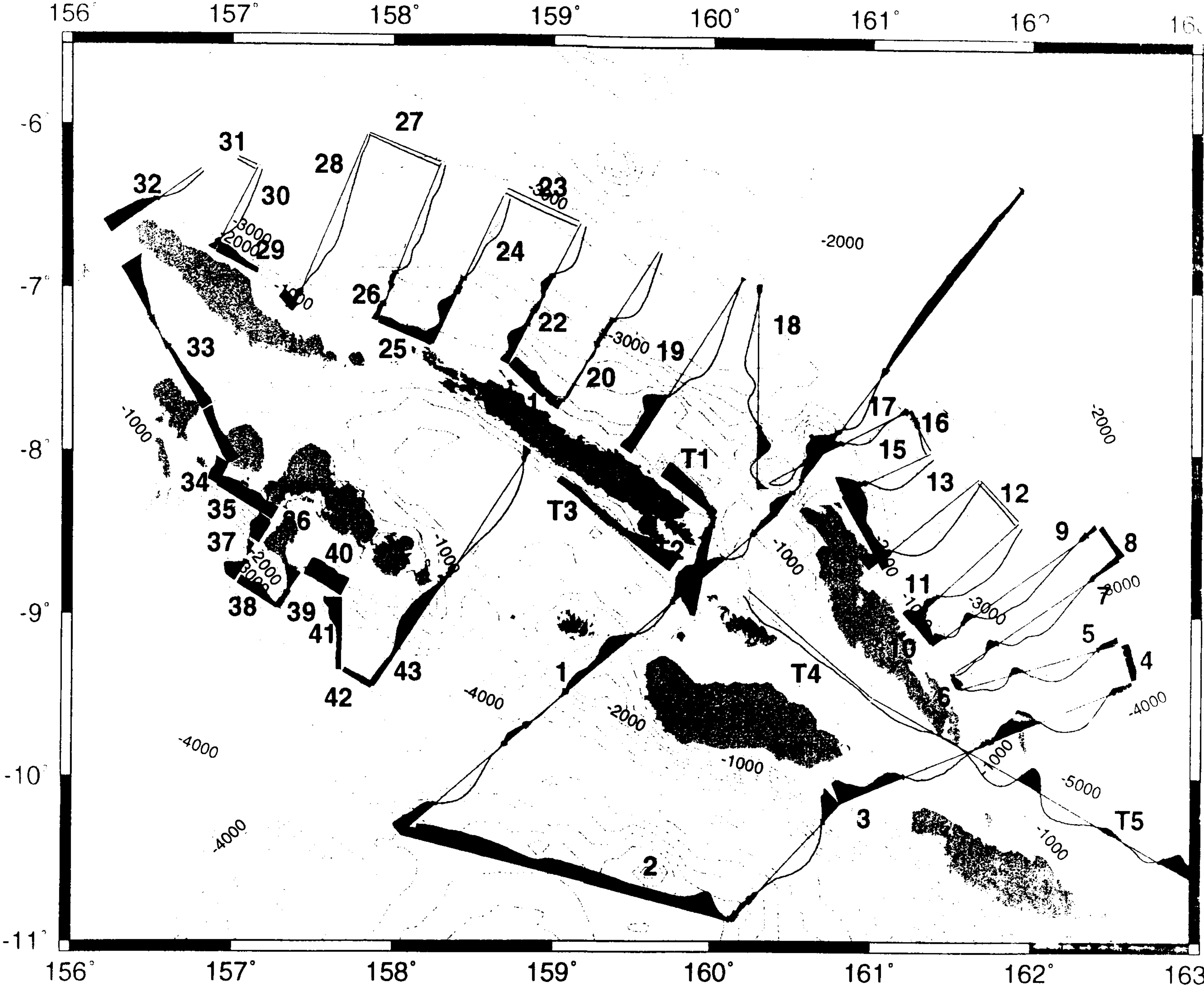

Figure 40. The shipboard free air gravity anomalies (FAA's) projected on the ship tracks of the EW95-11. Areas filled by black indicate positive FAA values. Note the close correspondence between the positive FAA's and the bathymetric highs on the seafloor.

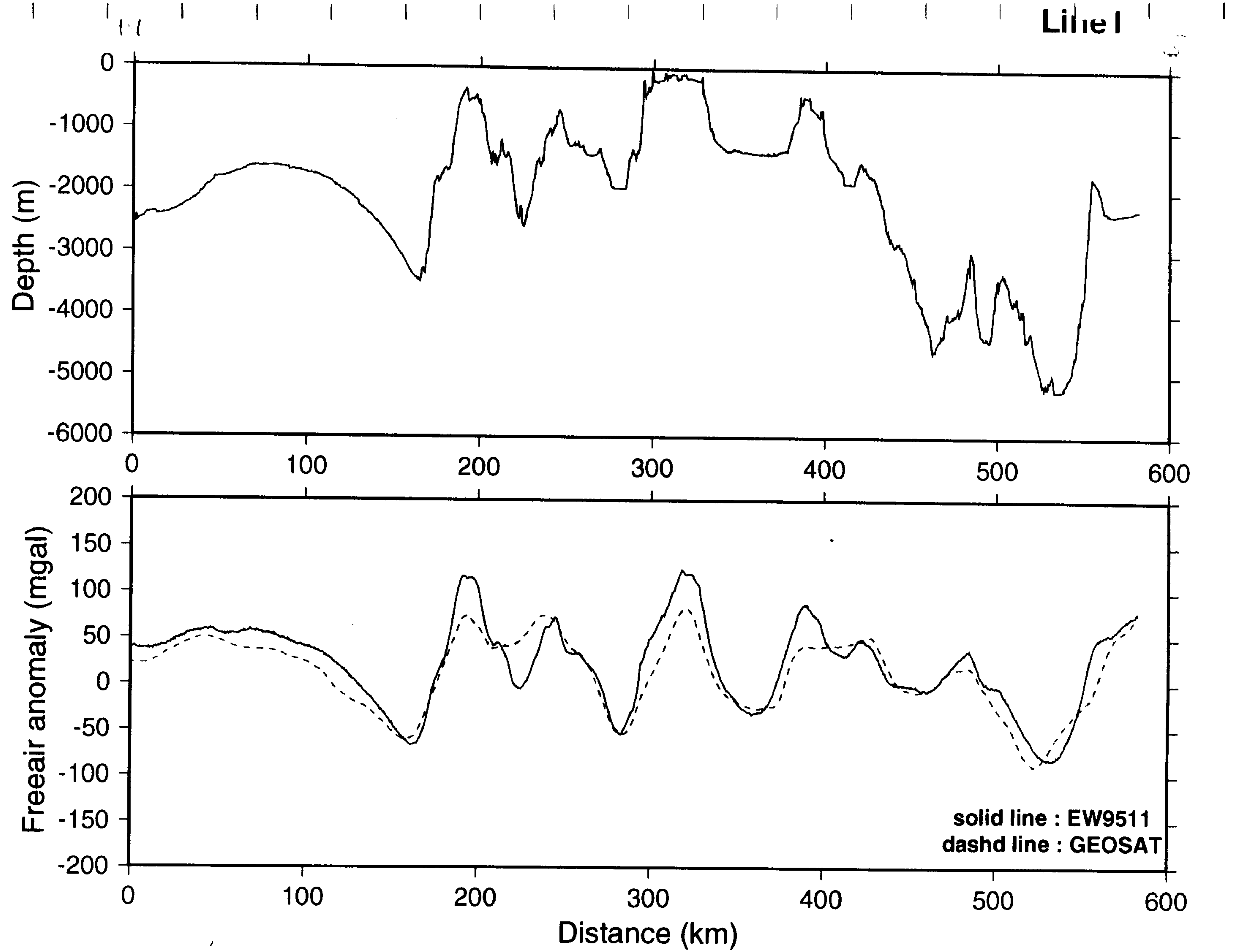

Figure 41. Gravity profiles along EW95-11 Line 1 of the shipboard FAA's (solid line) and the GEOSAT FAA (dashed line). The observed bathymetries collected by HydroSweep system are shown in the upper box. Note that there is generally a good correlation between the shipboard FAA's and the GEOSAT FAA's. Differences can be attributed to higher resolution spatially of the shipboard gravity measurements.

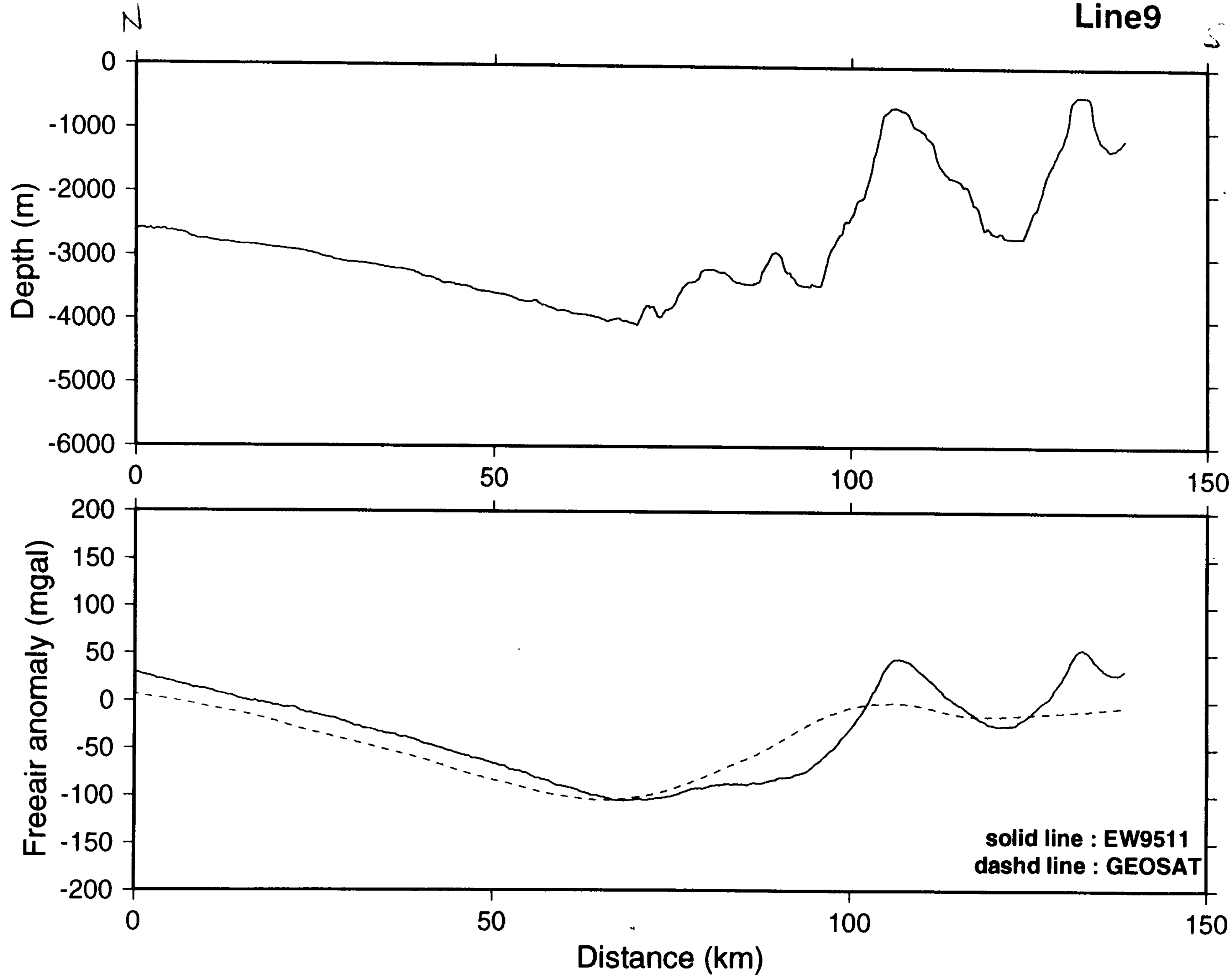

Figure 42. Gravity profiles along EW95-11 Line 9 of the shipboard FAA's (solid line) and the GEOSAT FAA (dashed line). The observed bathymetries collected by HydroSweep system are shown in the upper box. Note bathymetric high probably composed of accreted sedimentary rocks that lacks a postive gravity signature.

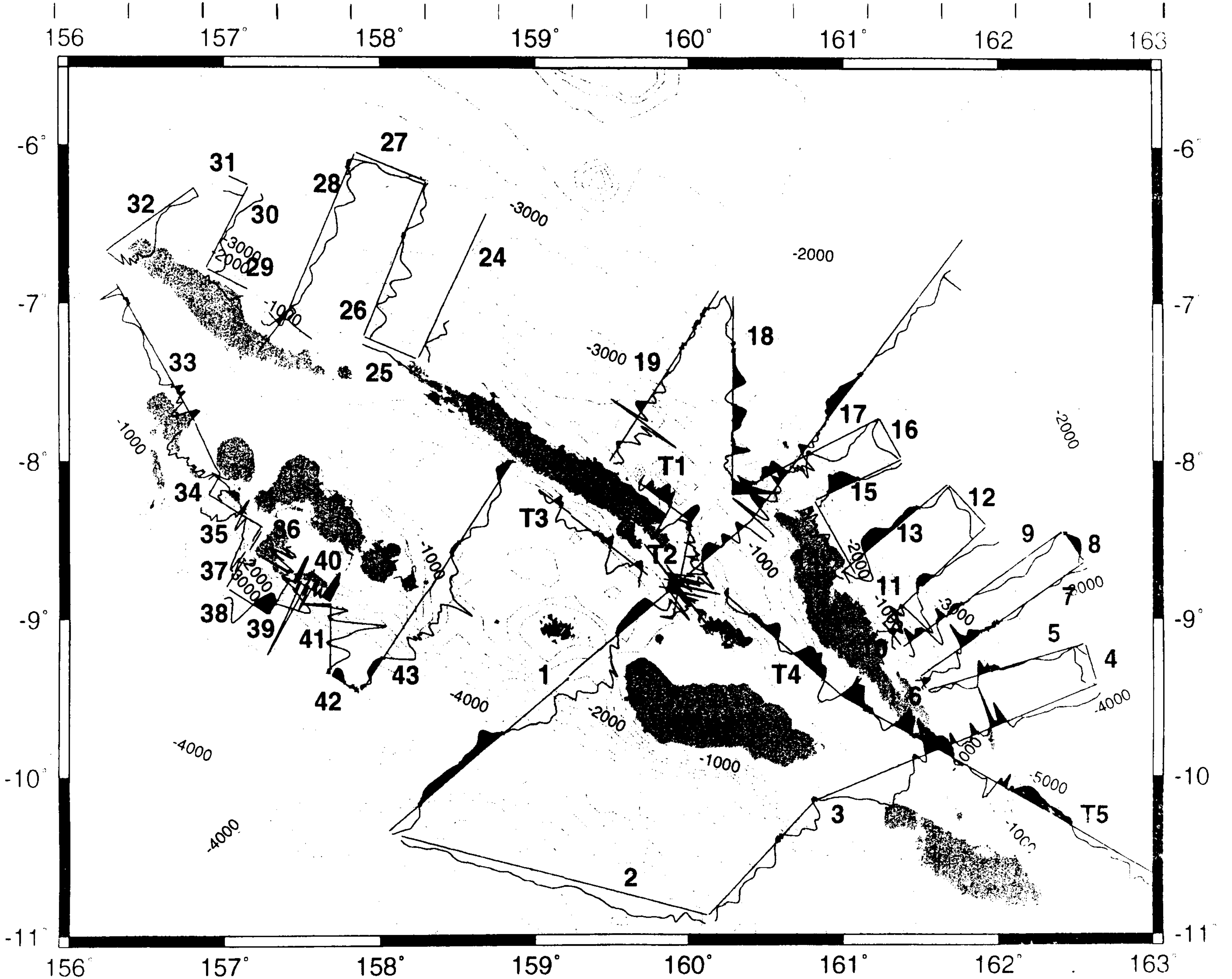

Figure 43. Magnetic profiles collected during EW95-11 and compared with bathymetry. The solid area is a positive anomaly and the scale is 63 mgal/mm. Note correspondence of magnetic positives with bathymetric highs in some, but not all, cases. Data gaps in magnetic observations are present along Lines 20, 21, and 23.

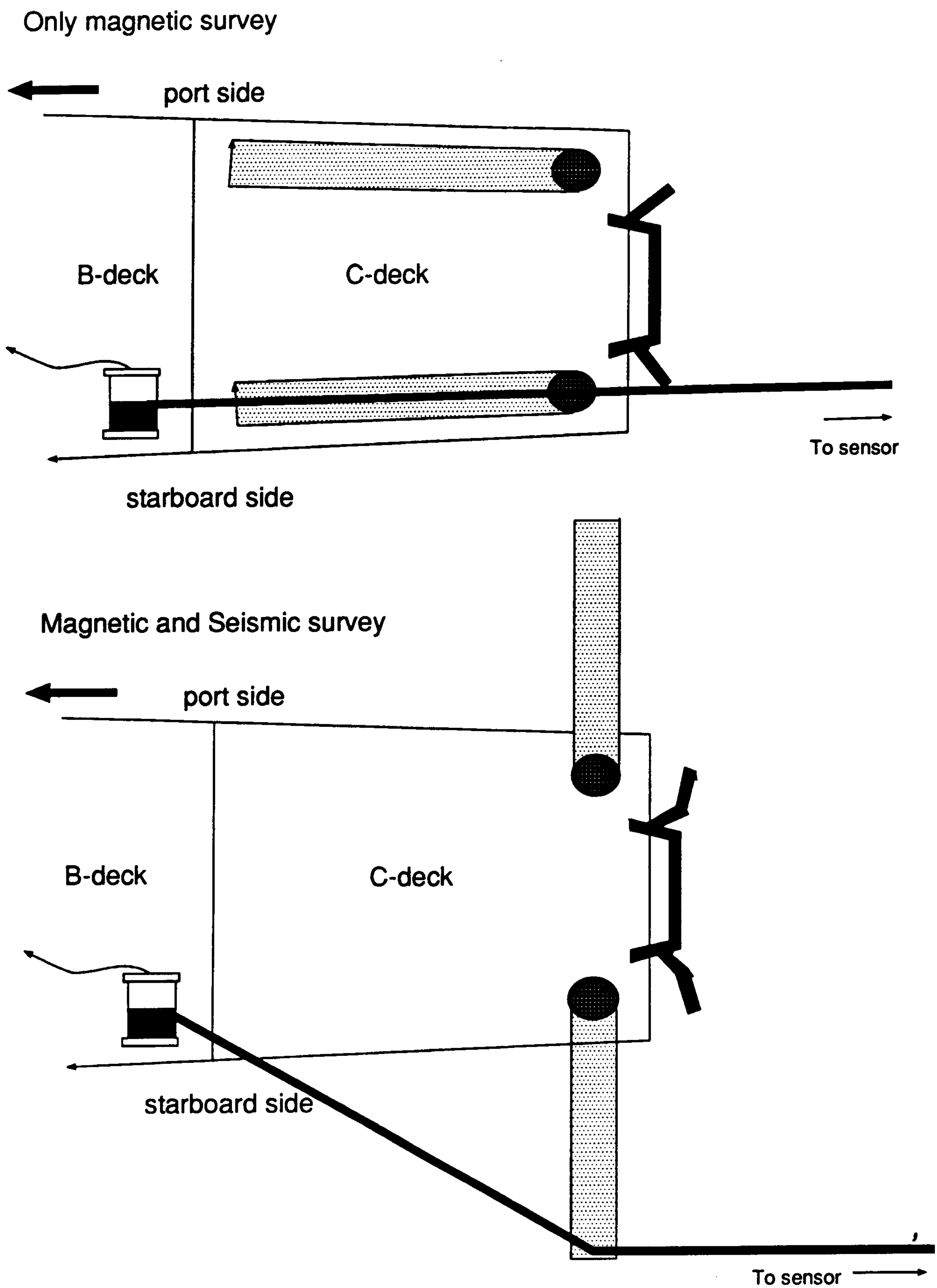

Figure 44. When both magnetic and MCS surveys are being conducted, the magnetometer is deployed from the end of the starboard airgun boom (lower drawing). Otherwise, it is towed directly behind the ship (upper drawing).

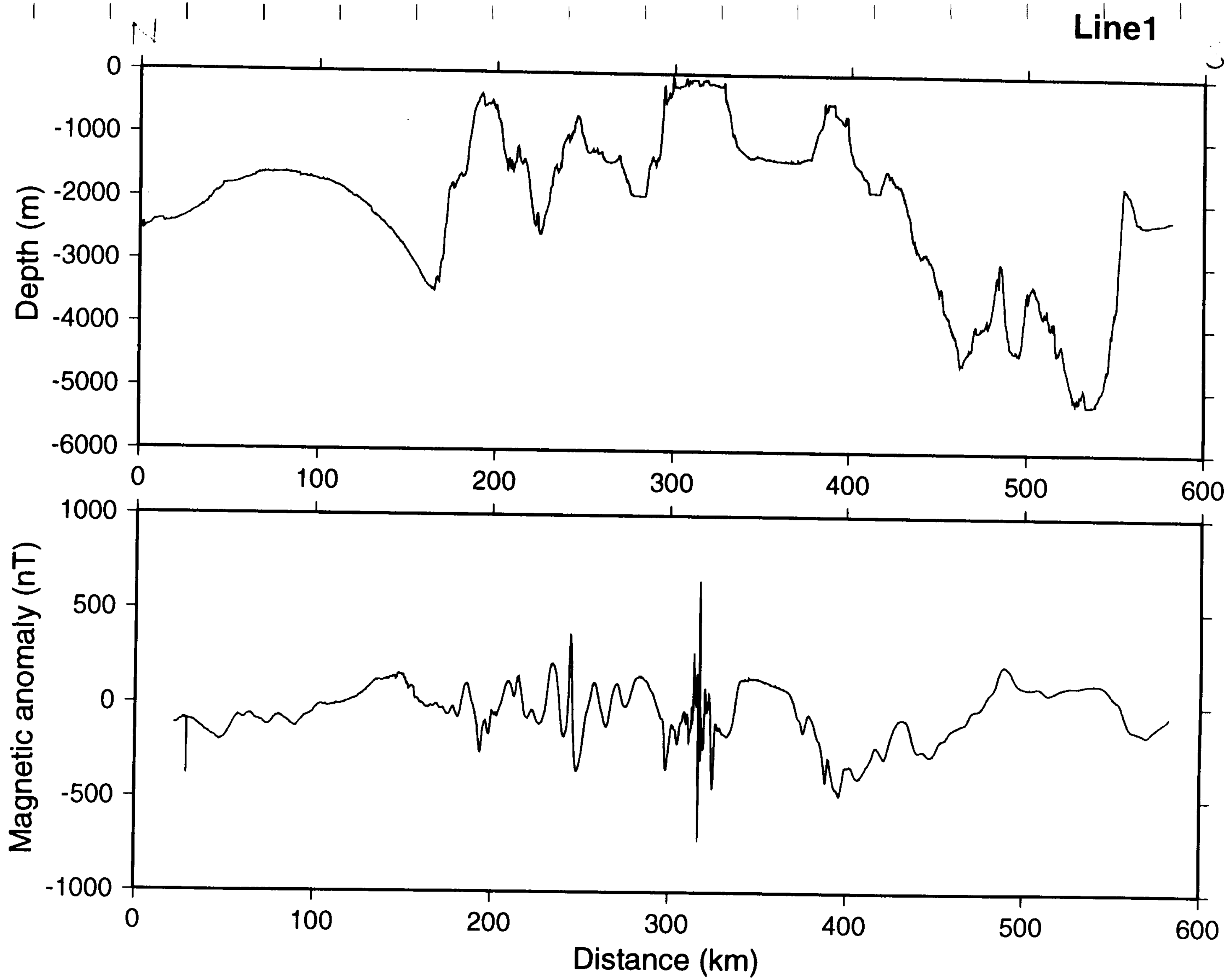

Figure 45. Magnetic profiles collected during EW95-11 along Line 1 and compared with Hydrosweep bathymetry in upper box. The prominent magnetic spike has been suggested as the possible suture zone between the Malaita anticlinorium and the Solomon island arc.