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CRUISE REPORT

R/V WECOMA W9506A

June 4th.-12th. 1995

Newport, Or. to Newport, Or.



Microearthquakes on the Endeavour Segment, Juan de Fuca Ridge: OBS Deployments

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SUMMARY

The primary objective of this cruise was to deploy a network of 15 ONR Ocean Bottom Seismometers for a period of two months to study the distribution and characteristics of microearthquake activity across the Endeavour segment of the Juan de Fuca Ridge. Although during this brief 8 day-long cruise we experienced a remarkable variety of weather conditions, from flat calm and sunshine to rain and 40 knot winds, all the goals were achieved without particular difficulty. A one day-long test deployment of two OBS was completed successfully and provided important data to guide the selection of the parameters that controlled data acquisition during the main deployment. A number of small microearthquakes, as well as three explosive test shots, were successfully recorded during this deployment. The primary network of 15 OBS was deployed during a two day period while the Research Vessel ATLANTIS II was simultaneously carrying out diving operations with the submersible ALVIN on this same ridge segment. This required close co-ordination between the bridge officers of both vessels. The fact that no difficulties were experienced is proof of the effectiveness of this co-operative effort. Approximately 50 explosive charges were detonated within and around the OBS network and all these charges were positioned within a few tens of meters of their intended positions sometimes during very poor weather conditions. This is testament to the navigational and ship-handling skill of the WECOMA's bridge officers. Unfortunately bad weather conditions at the end of the cruise prevented the planned transfer of Will Wilcock to the Atlantis II to enable him to participate in their continuing diving operations.

The recovery of all the OBS is scheduled for the first week in August, also from the Research Vessel WECOMA

In this report, following a short statement of the objectives, both scientific and operational, of the research project in general and this cruise in particular, the section entitled Summary Narrative provides an overview of the primary events of the eight days at sea. This is followed by the Main Lab Log Book that presents in some detail a chronological account of all operations. The final section of the main body of this report is a description of the results of the Test Deployment. The bulk of the hard data useful to those interpreting the results collected by the OBS is contained within the 12 Appendices. Here may be found, for example, tables of instrument locations (Appendix 2), shot locations and times (Appendix 3) and parameters that controlled the event detection algorithm in the OBS (Appendix 8) as well as technical descriptions of the new shot instant recording system (Appendix 10), the shipboard data processing system (Appendix 12) and the performance of the ONR OBS (Appendix 7). A description of the plan by which the Canadian Government requirements will be satisfied for reporting of scientific data collected within their waters is presented in Appendix 11.

SCIENTIFIC OBJECTIVES

- The overall objective is to study the distribution and characteristics of microearthquake activity across the Endeavour segment of the Juan de Fuca Ridge. The plan is to deploy a network of 15 ONR Ocean Bottom Seismometers (OBSs) for a two month period to span the axial valley in the vicinity of the main vent field and the Western flanks out to crustal ages of 0.5 My (~15km). Although the seismicity in this region has not been well characterized by studies to date, regional T-phase data show that many epicenters lie well off-axis in areas of ridge parallel bathymetry. The Endeavour segment appears to be in a tectonic phase of its evolution and this experiment has specific objectives to:
- Characterize the distribution and nature of off-axis microearthquake activity and to use these data to evaluate and refine existing models of the tectonic evolution of young oceanic crust as it moves off axis.
- Estimate the depth of the brittle-ductile transition from the maximum depth of seismicity as a function of distance from the ridge axis, and to relate the results to models of hydrothermal circulation and crustal cooling.
- Two auxiliary objectives will be to provide an opportunity to assess the errors in epicentral locations determined from regional US Navy acoustic arrays (SOSUS arrays) and, secondly, to provide high quality recordings of axial microearthquake swarms.

OPERATIONAL OBJECTIVES

- Deploy two OBS for 24-36 hours to monitor activity levels on and off the ridge axis and provide insight into selection of optimum recording parameters for the primary deployment.
- Deploy a full network of 15 ONR OBS to record microearthquake activity on the Endeavour segment of the Juan de Fuca Ridge for ~2 months.
- Carry out the first deep water deployment of a modified version of the ONR OBS that has sufficient battery capacity to operate on the ocean floor for approximately one year
- Shoot ~50 ten pound explosive charges within and around the OBS network to produce accurate relative and absolute instrument location information, orient the horizontal component seismometers and provide some constraints on shallow crustal velocity structure.
- Co-ordinate all these activities with those of the R/V ATLANTIS II, also operating on the Endeavour segment at this time, in order to minimise any possible interference between the two sets of operations.
- Carry out transfer of goods and personnel to R/V ATLANTIS II.

NARRATIVE SUMMARY

Loading of R/V Wecoma alongside in Newport Oregon began on Thursday June 1st. and, being ready for sea, at 9am Sunday June 4th. the explosives (see Appendix 6) were loaded immediately prior to departure. Following two lowerings of the CTD wire to carry out the routine tests of the EG&G acoustic releases, the vessel arrived at the Endeavour segment of the Juan de Fuca Ridge in the middle of the following day and two OBSs were deployed for a short test experiment to determine the level and nature of microearthquake activity, and help refine the parameters for event detection. OBS #62 was deployed off axis and OBS #58 was deployed within the axis near latitude $47^{\circ} 56.6'N$ (see Appendix 2). The parameters that controlled the data acquisition are presented in Appendix 8, along with a brief rationale for their selection. Immediately following these deployments the remaining two wireline lowerings were carried out to test the acoustic releases.

At 630 pm Monday June 5th R/V Atlantis II, which was also operating on the same segment of rise crest, sent a small boat to receive mail and packages that Wecoma had brought out for her. When this rendezvous was completed we began tests for our explosives shooting operations, successfully detonating a series of three 10lb. charges and recording their shot instants and bubble pulse periods (see Appendices 3 and 10). The vessel then hove-to overnight. The morning of Tuesday June 6th was spent in continued preparations of the OBS instruments for deployment. The weather deteriorated throughout the day until by late afternoon it was blowing ~30knots. The recovery of the two OBS from the test deployment was completed without incident despite the difficult conditions, the second instrument being hooked-on alongside at 835pm. We were surprised by the greatly increased rise rate of the OBS now that two more glass balls had been added to the frame - now it is ~60m/min. compared with ~40m/min previously. Preliminary inspection of the test deployment data indicated that both instruments had recorded useful data. Examples of the recorded events are given in a later section of this report. Concerns about whether the 'lockout' feature in the acquisition program had been operating properly proved to be without foundation following a couple of satellite phone conversations with Ken Peel back at WHOI (see Appendix 7).

Deployments of the OBS for the main experiment (see Figure 1 for a schematic view of the network layout and Appendix 2 for locations) began after lunch on Wednesday, June 7th., seven instruments being successfully deployed before operations were suspended for the night at 9pm. The weather had moderated substantially. Three of these seven instruments were located on the rise axis and continued communication with the AII was required to ensure that we did not interfere with each others operations. The small deck crane failed and was not repairable at sea, so it was necessary to carry out all remaining deployments with the main crane. Thursday morning was spent working on the one-year OBS batteries that required replacement of fuses, this instrument (OBS #51) being deployed at approximately 1045 am in very calm conditions - wind speeds were less than 10knots, highly unusual for Juan de Fuca! A sink rate of 90m/min was recorded for this unit! Because of this it had been located intentionally within what we believed to be an off-axis sediment pond. The remaining seven OBS were deployed by 7pm uneventfully and we steamed away from the ridge to keep clear of Atlantis II operations and hove-to overnight.

Our contingency day, Friday, was spent hove-to - the instruments did not start recording in continuous mode until 1805 local time Friday evening, so there was nothing to be done. Unfortunately, during the day, Friday, the weather again deteriorated until it was blowing 30 knots in the afternoon, the weather map showed a very large depression and the forecast was extremely bad for the next 48 hours. Shooting operations (see Appendices 3,4 and 6) began at 6 pm on Friday but were temporarily abandoned after one shot. The

seas were too high and we were taking seas on the fantail sufficiently large to hinder the operations of the shooters. The shooting tracks were replanned to permit shooting only when we were running before the seas. In this way we were able to complete 13 shots on Friday night in wind speeds substantially in excess of 30 knots. We were unable to contact Atlantis II during this time (nor was she visible on radar at 24 mi range) so we could not determine her diving plans for the following day.

Saturday morning brought a substantial and completely unexpected improvement in the weather. The rain and strong winds were no more. Just blue skies and 15-20knot wind speeds. We managed to shoot 11 more shots, beginning at 8am before we were requested by Atlantis II to cease operations because ALVIN was diving. At 1030am we secured from shooting operations and hove-to for the rest of the day until the submersible was recovered and shooting could recommence. Shooting indeed recommenced at 445pm and proceeded quickly and without delays. We were steaming at full speed in close proximity to the AII and the bridges of the two vessels did an excellent job of co-ordinating their actions in order to minimise the interference with each others science operations. A total of 24 charges were detonated, all within a few tens of meters of their intended positions, by 845pm. The remaining one ten pound charge and the left-over Primacord were made into a single charge that was detonated in the center of the network. We secured from explosive operations for the last time at 930pm and hove-to overnight to await the planned rendezvous with the AII early in the morning to transfer Will Wilcock.

The weather had deteriorated sufficiently overnight that it was not possible to carry out the transfer of Will to the AII so at 730am Sunday 11th June we set course for Newport, heading into heavy seas and 30 knot winds.

We were alongside in Newport by 11am Monday 12th June and began unloading the ship after a very successful cruise. All objectives (except transferring Will to the AII) had been achieved. The research vessel WECOMA (Appendix 5) had performed supremely well under difficult weather conditions and in the face of complex navigational demands by the science party.

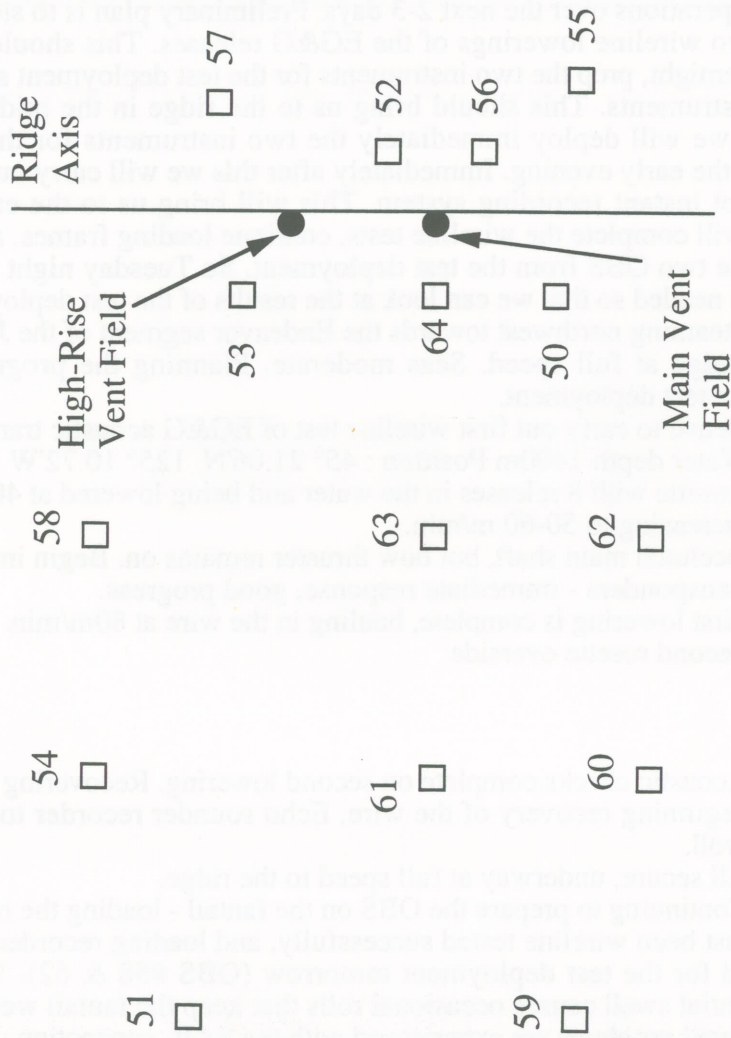


Figure 1. Schematic diagram showing the layout of the OBS network which spans the axial valley and extends about 14 km to the west.

LOG BOOK

Thursday, June 1st. Begin loading ship alongside in Newport Or.

Saturday, June 3rd. All 15 OBSs checked out, science personnel move on board

Sunday, June 4th.

1600UT (0900LT) Loading explosives

1615UT Depart Newport for sea, calm and cloudy and cold!

1740UT (1040LT) Fire and Boat Drill completed - science meeting held to develop plan for operations over the next 2-3 days. Preliminary plan is to stop at 3pmLT this afternoon and carry out two wireline lowerings of the EG&G releases. This should take 4-6 hours. Then continue to steam overnight, prep the two instruments for the test deployment and begin loading the frames of the other instruments. This should bring us to the ridge in the middle of tomorrow afternoon. At which time we will deploy immediately the two instruments for the tests, and then rendezvous with the A2 in the early evening. Immediately after this we will carry out test shooting to check operation of the shot instant recording system. This will bring us to the end of the day on Monday. On Tuesday we will complete the wireline tests, continue loading frames, and in the middle of the afternoon recover the two OBS from the test deployment. So Tuesday night will be when the data transfer system will be needed so that we can look at the results of the test deployment.

1930UT (1230LT) Steaming northwest towards the Endeavor segment of the Juan de Fuca Ridge at full speed. Seas moderate. Planning the programming for the instruments to be used in the test deployment.

2200UT (1500LT) Heave to carry out first wireline test of EG&G acoustic transponder releases
Water depth 1400m Position : 45° 21.06'N 125° 10.72'W

2212UT (1512LT) Rosette with 8 releases in the water and being lowered at 40m/min., increasing to 50-60 m/min. .

2235UT (1535LT) Declutch main shaft, but bow thruster remains on. Begin interrogating the transponders - immediate response, good progress.

2300UT (1600LT) First lowering is complete, hauling in the wire at 80m/min.

2318UT (1618LT) Second rosette overside

Monday June 5th.

0003UT (1703LT) Acoustic checks complete on second lowering. Recovering transducer and beginning recovery of the wire. Echo sounder recorder took a dive off the lab bench during a modest roll.

0030UT (1730LT) All secure, underway at full speed to the ridge.

0200UT (1900LT) Continuing to prepare the OBS on the fantail - loading the releases that had just been wireline tested successfully, and loading recorder packages on the two units that will be used for the test deployment tomorrow (OBS #58 & 62). Weather remains reasonable although substantial swell causes occasional rolls that keep the fantail wet. When we hook into the first OBS on the fantail problems are experienced with the SAIL connection. Very quickly this problem is traced to a small plug that had been pulled out of the top of the SAIL card in the recorder package (34) - presumably the wire had caught on the side of the pressure case while it was being loaded and this must have been enough to partially pull out the plug.

1415UT (0715LT) Continuing to steam at full speed to the north-west towards the ridge.
Weather remains moderate, sizable swells but maintaining good speed.

1530UT (0830LT) Discover problem with battery pack in recorder 34 that was loaded on to the OBS #62 frame last night. Two cells within the battery pack were dead.

This is a big worry because we are using a new manufacturer for the battery packs and this is the

second pack with which we have had a problem. These cells are internally fused and apparently it takes very little to blow those fuses. There is the added complication that it seems possible that the disc on OBS #62 was left running all night because the reset switch (that usually turns off the disc) did not do so for some reason. The contacts on this switch and the cabling will be checked. The plan right now is to deploy the off axis OBS first (at around 1300 this afternoon) and start the formal pre-deployment checks at 10am.

1930UT (1230LT) Approaching drop site for first OBS to be deployed off-axis for the test deployment. ATLANTIS II is in sight off the starboard bow. Delaney is diving in the submarine today. The *planned* drop locations are as follows:

| | | | |
|----------|-------------|-------------|---------|
| Off-axis | 47° 57.92'N | 129° 9.71'W | OBS #62 |
| On axis | 47° 56.61'N | 129° 5.87'W | OBS #58 |

2000UT (1300LT) Hove to at the OBS#62 deployment site, preparing the OBS frame on deck. Electronics for both instruments programmed and ready to go.

2052UT (1352LT) **OBS#62 Overside**
Position 47° 57.97'N 129° 9.71'W

Water depth 2325 corrected meters (from Seabeam map)

2105UT (1405LT) Underway to the next OBS drop site at 6 knots.

Heave to near location for OBS#58 drop. A2 calls expressing desire for a rendezvous at 430-500pm.

2145UT (1445LT) Hydraulic line broken on the small deck crane - everything on hold until we sought out what to do.

2200UT (1500LT) Continuing OBS prep operations with crane but just not using the boom extension - hopefully it can get fixed before we need it for recoveries tomorrow night, but it seems we can manage for the deployments right now.

2212UT (1512LT) **OBS# 58 Overside**
Position 47° 56.64'N 129° 5.89'W

Water depth 2250 meters corrected meters (from Seabeam map)

2230UT (1530LT) Decision made to carry out wireline tests at this same location - plan is for AII to rendezvous after we have completed the first lowering.

2235UT (1530LT) Rosette going overside for wireline test of 8 more releases.

2252UT (1552LT) Winch stopped at 1000m wire out - commence interrogation of releases.

2324UT (1624LT) Tests successfully completed - commence recovery of releases.

2340UT (1640LT) Releases recovered on deck preparing for second lowering. Now the plan is for AII rendezvous at 530pm - coz of interference with meal times they said.

2345UT (1645LT) Another lowering of releases commences

Tuesday June 6th.

0010UT (1710LT) Wire at 1000m - start interrogation and command tests - this is the 4th and final lowering.

0035UT (1735LT) Tests complete -commence recovery of the wire.

0050UT (1750LT) Releases on board, AII within half a mile - maneuvering for rendezvous by rubber boat. Preparing for tests of the shot instant recording system.

0130UT (1830LT) Rubber boat came over from AII - took stuff and brought us some hydraulic hose. Clear, now trolling off to the west to test explosive shot recording.

0210UT (1910LT) Launch shot instant hydrophone for tests - increase speed to 10 knots - then decrease back down again. It seems to be working although there is a lot of crackling. This a completely new system built just for this cruise - never before used.

0220UT (1920LT) Request bridge for clearance for explosive operations.

0300UT (2000LT) Start test shooting ops. Shot times below. Steaming at 10knots to and fro over OBS #62: the first two shots fired right over the OBS, the third one

about 2 n.m. to the west.

Test Shot #1 0312:07.367

Test Shot #2 0331:49.960 47° 57.91'N 129 09.67'W

Test Shot #3 0350:06.262 47° 59.21'N 129 11.06'W
 All three were 10lb PETN booster with 4' of 150 grain primacord, 26" fuse giving a 65 second burn time and a bubble pulse period of 96 milliseconds

0355UT (2055LT) End of totally successful test shooting operations. Stooing around overnight. Shot instant hydrophone recovered - the new one Koelsch built without a preamp worked without a problem despite some fears.

1440UT (740LT) Still hove to, weather remains moderate although there has been a definite increase in wind speed. The priority today is to get the remaining acoustic releases and recorder packages loaded onto their frames. And we must get the one year instrument squared away. But after the successes of yesterday we are in good shape. Plan to release the first test OBS at 5pm this afternoon.

1800UT (1100LT) Preliminary decisions made on the deployment order for the OBS and the recording programs are established. We remain comfortably hove-to. Working on loading the OBS frames. Wind speed 20-25 knots.

2230UT (1530LT) No longer so comfortable - blowing a solid 25 knots and lotsa whitecaps, occasional substantial rolls as we steam slowly back toward the OBS drop site preparing to recover a little after 5pm this evening. All recorders are out on the frames and instrument checking continues. The one year instrument is rigged and the programming for the instruments for the main deployment has been determined preliminarily.

Wednesday, June 7th.

0000UT (1700LT) Maneuvering into position to release OBS#62. Wind blowing 30knots.

0010UT (1710LT) Confirmed release after sending release command three times, although it did enable on the first command. Predicted surface time is 1808 local.

0015UT (1715LT) Recover transducer, ship clear to maneuver. Requested we be back on site at 1755LT.

0048UT (1748LT) OBS #62 sighted on the surface by the bridge - way earlier than expected rise rate 61 m/min. Wind 26-28 knots, lotsa white caps.

0106UT (1806LT) Hooked on, **OBS #62 alongside.**
 Position: 47° 57.90'N 129° 09.74'W

0120 UT (1820LT) OBS #62 secure on fantail - a difficult recovery. Line to pickup hook snapped during recovery. Fortunately it proved possible to hook on again before the instrument drifted out of range. A challenging recovery for the bridge - they did an excellent job. Checked radio beacon on bridge - it was working fine.

0155UT (1855LT) Deck checks on OBS#62 look good. Powering down and bringing in the recorder package to the lab. Inspection of data over serial link shows two major events which are believed to be the two sugar releases, that occurred at 2326UT and 2336UT respectively, 2hours 34min and 2hours 44mins after the instrument was deployed.

0210UT (1910LT) All secured steaming to recover OBS#58 - predicted rise time is 38mins @ 60 m/min

0240UT (1940LT) Maneuvering into position over OBS #58 to start release procedure.

0247UT (1947LT) Confirmed release OBS #58. Predicted surface time is 2025LT, assuming the rise rate of 60m/min. Still blowing 28knots.

0323UT (2023LT) Surface 30m off port bow!! 62.5m/min rise rate.

0335UT (2035LT) Hooked on - **OBS #58 alongside**
 Position: 47° 56.58'N 129° 05.89'W

0350UT (2050LT) OBS #58 secure on deck

0400UT (2100LT) Still we have not been able to open the recorder package for OBS #62 because of fear of condensation problems It is still sitting in the lab warming up - the plan of doing substantial data analysis tonight seems to be falling apart. The weather forecast predicts strong winds (40knots), for the next 24 hours. We have a problem with the one-year-OBS battery pack. One of the voltages has dropped to zero, presumably because one of the internal fuses has blown. But why? Requires opening the pressure case and this cannot be done with a fantail that is

constantly awash, and it is too big and heavy to be brought into the lab. So that is a problem that will have to wait until the weather improves.

0415UT (2115LT) Internal temperature in OBS #62 recorder package is 15°C so decision is made to open it up, at last!

0440UT (2140LT) Recorder package for OBS#58 is brought into the lab. It was not possible to address it on deck - but now it seems fine - hypothesis is that it is a problem with the deck cable. Apparently it recorded more data than #62, so maybe everything worked..... Remarkably the Sauter compasses seem to have worked fine on both the instruments.

0630UT (2330LT) Inspection of data from OBS #62 is encouraging - no event triggers on the hydrophone channel but lots of good events when triggering on the vertical with a threshold ratio of 3. The explosive shots were well recorded. Presently loading the OBS #58 data into the Suns so we can do a similar inspection.

0730UT (0030LT) Data from OBS #58 looks OK too - very different character of activity and possible indications that the sensor package was tilted substantially i.e. channel 3 response is poor - we see reasonable data on the shots but for all of the events no good signal is visible on channel 3. There are large numbers of swarm events. The single biggest problem is that the lockout apparently did not work - during one 6 hour period there were more than 120 events. The program was set to stop at 100. This lockout facility worked during the FARA project and with the identical version of the code (3.54) that is being used here, so this is not well understood. But it looks like the instrument generally worked. Still hove to - wind still over 25 knots. Not clear how much can be accomplished tomorrow given the sea state.

1500UT (0800LT) Wind speed has steadily decreased overnight - now blowing 22-24 knots. Seas still high. Working on turning around OBS #58 and #62 and thinking about starting to deploy this lunchtime if the weather continues on this trend. Also there is a need to resolve the reason that the lockout did not work.

1630UT (0930LT) Working on trying to understand the lockout problem on OBS #58 i.e. why did it not lockout after recording 100 events in 6 hours? Should the max number be input in hex instead of decimal? Apparently not. It worked fine on FARA - we checked FARA log files. Try to call Peal but get his machine. Discuss switching to spare sensor package on OBS #58 because of poor data on channel 3 but there seems to be more uncertainty about the performance of that sensor than the one that we used in the deployment - some vague story about Stan Rosenblad having reversed the gimbals in order to balance them, and no real stomp test (with the sensor hooked up to an acquisition package) had been carried out. So decide not to swap out the sensor package on OBS #58. Decision made to proceed with the prep of #58 and #62. No solution to the lockout issue is found. GMP will try to contact Ken Peal by phone to discuss the issue with him. In the mean time the weather continues to improve - the wind speed is steadily decreasing so we must get on with instrument deployments. Decision made that at least for the off-axis instruments the event triggering will be done from the vertical sensor throughout and the threshold ratio will be 3. Decision about what we do with the on-axis instruments is under review.

1730UT (1030LT) Spoke with Ken Peal via satellite phone - he had no new insights on the lockout problem but will contact us if has any ideas after reviewing the code.

1830UT (1130LT) Prepping OBS #58 for deployment. Decision made to delay deployment of the one-year unit (#51) until tomorrow. Goal is to try to get some on-axis units in the water tonight. Peal called back with a complete explanation for the lock-out problem. It is a none-problem!. The timer that counts events starts its time period at the time of programming of the instrument, not at the start of the program phase. So what we saw was not a failure of the program - we were counting events within the wrong 6 hour time periods.

2028UT (1328LT) **OBS # 58 overside**

Position 48° 00.04'N 129° 07.87'W

Water depth 2365 corrected meters from Seabeam map

2045UT (1345LT) Underway at 5 knots towards OBS#62 drop site. Replacing the geophone cable on OBS #62 and then this requires reprogramming.

2145UT (1445LT) In position preparing to deploy OBS #62

2157UT (1457LT) OBS #62 overside
 Position 47° 56.12'N 129 10.68'W
 Water Depth 2315 corrected meters from Seabeam map
2215UT (1515LT) Underway to deployment site for OBS #61
2259UT (1559LT) OBS #61 overside
 Position 47° 58.84'N 129° 12.59'W
 Water Depth 2545 corrected meters from Seabeam map
2305UT (1605LT) Underway to deployment site for OBS #52 on the ridge axis.
2340 UT (1640LT) During deck tests of the releases on OBS #52 one unit released the anchor without being given the release command. When it was recocked and a disable command was transmitted, it responded with a one second timed ping - indication that it had released again. Decision made to swap out the release with one of the spares that had been borrowed from SIO. Slow to 1knot while this work is carried out on the fantail.

Thursday, June 8th.

0020UT (1720LT) Maneuvering into position to deploy OBS #52. Passing astern of the AII
0036UT (1736LT) OBS #52 overside
 Position 47° 57.28'N 129° 05.39'W
 Water depth 2220 corrected meters from Seabeam map
0044UT (1744LT) Underway to site for deployment of OBS #56
0158UT (1848LT) OBS #56 Overside
 Position 47° 56.70'N 129° 05.75'W
 Water depth 2225 corrected meters from Seabeam map
0205UT (1905LT) Maneuvering into position to deploy OBS # 64
0230UT (1930LT) Ship's engineers are working on the small deck crane - there has been difficulty in getting it to slew when loaded with an OBS.
0247UT (1947LT) OBS # 64 Overside
 Position 47° 57.12'N 129° 06.27'W
 Water depth 2100 corrected meters from Seabeam map.
0255UT (1955LT) Steaming to launch position for OBS #55
0339UT (2039LT) OBS #55 Overside
 Position 47° 55.55'N 129° 05.46'W
 Water depth 2135 corrected meters from Seabeam map.
0400UT (2100LT) End of operations for the night - steaming slowly overnight to the OBS #51 deployment site.
1500UT (0800LT) Starting to work on OBS #51 - excellent weather conditions, winds less than 10knots. The small deck crane has been ruled inoperative - will have to use the main fantail crane from now on for instrument deployments.
1730UT (1030LT) Maneuvering into position to deploy the one-year OBS #51
1743UT (1043LT) OBS#51 Overside
 Position 48° 01.07'N 129° 15.02'W
 Water depth 2525 corrected meters from Seabeam map
 Staying on site to monitor sink rate and check that when it hits bottom, nothing breaks. Slant range currently increasing at 90m/min.
1811UT (1111LT) OBS #51 hits bottom EG&G deck unit indicated 2504m.. Sink rate was indeed 90m/min.
1955UT (1255LT) OBS# #63 Overside
 Position 47° 58.08'N 129° 09.52'W
 Water Depth 2320 corrected meters from Seabeam map.
2005UT (1305LT) Getting underway towards the OBS #60 launch site.
2050UT (1350LT) OBS #60 Overside
 Position 47° 56.90'N 129 13.99'W
 Water Depth 2590 corrected meters from Seabeam map

Position 47° 56.90'N 129 13.99'W
 Water Depth 2590 corrected meters from Seabeam map
2100UT (1400LT) Getting underway towards the deployment site for OBS #59
2141UT (1441LT) **OBS# 59 Oversight**
 Position 47° 58.50'N 129° 16.83'W
 Water Depth 2490 corrected meters from the Seabeam map
2150UT (1450LT) Getting underway to deploy #54. Weather remains calm - substantial swell left over from yesterday, but winds speeds remain less than 10 knots.
2231UT (1531LT) **OBS #54 Oversight**
 Position 48° 00.96'N 129° 11.38'W
 Water depth 2445 corrected meters from Seabeam map
2240UT (1540LT) Underway to deployment site for OBS #53
2329UT (1629LT) **OBS #53 Oversight**
 Position 47° 58.88'N 129° 05.72'W
 Water depth 2100 corrected meters from Seabeam map
2340UT (1640LT) Underway to deployment site for OBS #57

Friday, June 9th.

0017UT (1717LT) **OBS #57 Oversight**
 Position 47° 58.10'N 129° 04.42'W
 Water depth 2120 corrected meters from Seabeam map
0025UT (1725LT) Underway to deployment site for OBS #50
0138UT (1838LT) **OBS #50 Oversight**
 Position 47° 56.24'N 129° 06.83'W
 Water Depth 2200 corrected meters from Seabeam map
0150UT (1850LT) Underway to clear the ridge axis and heave to overnight
1500UT (0800LT) Still hove to - cannot start shooting until 6pm tonight because the OBS do not turn on until then. Wind speed back up to 20 knots: not so calm as yesterday. Weather forecast looks bad.
2100UT (1400LT) Hove to waiting for the OBS to turn on so we can start shooting. Weather continues to deteriorate - now blowing 26-28knots out of the south. Fantail is secured for preparation of explosive charges. Shooting on E-W tracks will make the ship's roll the limiting factor that will control whether we can shoot tonight as planned. Intercom installed on fantail for communication to the shooters - tested and works fine.

Saturday June 10th.

0100UT (1800LT) Start explosive shooting operations in extreme heavy weather. Winds over 30 knots and rain and high seas. Fire one shot and then temporarily abandon operations because the east-west tracks resulted in too much water on the fantail. Shooting operations were becoming unsafe. Replanned the order of the shots to allow tracks running to the north (running before the seas) and then returning slowly to the south into the seas without shooting.
0730UT (0030LT) Completed three of these runs to the north. Successfully detonated a total of 13 shots but had two duds at waypoint numbers #10 and #39. Shot instant recording system performed flawlessly. Unable to contact AII all evening and she is not visible on radar at 24 mile range, so we are not sure what her plans are for tomorrow. The front came through at around 0530UT and the wind dropped precipitously to 15-20knots. Heaving to overnight after maneuvering into position to the south to be ready to start another run north in the morning. Some concern about whether the AII will dive tomorrow given the rapid and somewhat unexpected improvement in the weather.
1430UT (0730LT) Weather has improved dramatically in spite of what the forecast said - wind now below 20 knots. In position to start another shooting run to the north, but the AII is talking about diving today - they have not yet decided. They told Will on the radio that it

- 1530UT (0830LT)** Discussions ongoing with AII regarding efficacy of our shooting - they are launching the ALVIN.
- 1730UT (1030LT)** Secure from shooting - managed to fire a total of 11 shots being careful to remain more than 4 miles from AII. At one point AII requested we cease shooting because of complaints from the ALVIN pilot but then they allowed us to fire two more given they were slightly more distant and they proved not to be a problem. Will spend the day hove-to waiting for the submarine to be recovered this afternoon, at which point we will fire the remaining 24 charges. We hope to be able to start at around 430pm.
- 2345UT (1645LT)** Begin shooting - ALVIN is out of the water and at last we can get on with the shooting. A total of 24 shots remain, but the weather is now such that we can shoot on any course so we set off at 12 knots and make excellent progress.

Sunday June 11th

- 0345UT (2045LT)** With a short half hour break for dinner we had completed all the planned shots, including filling in the two duds of last night. Good co-operation from the AII in keeping out of our way as we steamed around them at full speed firing charges. Shot instant recording went well and the excellent GPS navigation allowed us to place all the charges within tens of meters of their planned locations. One ten pound charge remaining along with a couple of reels of primacord.
- 0420UT (2120LT)** Fired one last charge in the middle of the network using up all the explosive and primacord that was left.
- 0429UT (2129LT)** Shot instant hydrophone recovered, all science operations completed. All objectives of the cruise have been attained. Heave-to overnight to await rendezvous with AII tomorrow morning to transfer Will Wilcock to the AII. Weather remains moderate - wind speed 15-20 knots.
- 1430UT (0730LT)** Wind speed around 30 knots - decision made that transfer of Will Wilcock to the AII is not safe and reasonable, therefore set course for Newport at full speed.

Monday, June 12th

- 1800UT (1100LT)** Alongside in Newport, begin unloading

TEST DEPLOYMENT

The primary objective of the test deployment was to refine the acquisition schedule for the main deployment and in particular to optimize the short to long term trigger ratio and the channel for the event detect recording. The acquisition schedule used for the test deployments (Appendix 8) was a shortened version of that planned for full deployment with the same sequence of continuous (windowed) and event detect recording. Two 2 hour periods of continuous recording were interspersed with three 7 hour periods of event detection, two of which triggered off the vertical channel and one off the hydrophone. One instrument (OBS 58) was located near the ridge axis just to the south of the Main vent field and the other (OBS 62) 5 km to the west of the ridge axis. Because we anticipated a higher level of swarm activity on-axis, the short term to long term trigger ratio for the vertical channel was set at 7 for OBS 58 and 3 for OBS 62. The trigger ratio for the hydrophone was set to 3 on both.

Both OBSs recorded good data although the second horizontal channel on OBS 58 was probably poorly leveled since the only discernible events on this channel were explosive shots.

Both the OBSs recorded all three test shots (Figures 2-4) which were detonated during the first period of event detection (Appendix 6). Figure 2 shows a test shot fired immediately above OBS 62. The first arrival is very clear on all channels. The hydrophone amplifier saturated and failed to record good data for two seconds although the first water-column multiple is well recorded. One of the horizontal channels also saturated the A/D system. Good refracted crustal arrivals were recorded on the hydrophone (Figures 3-4) and vertical channels (Figure 3) for shots fired several kilometers away from both instruments

The number of triggers during each event detect period is shown in the following table.

| | OBS 62 (Off-Axis) | OBS 58 (On-Axis) |
|--|-------------------|------------------|
| Event Detect Period 1 (7 hr) Vertical Seismometer | 90 | 137 |
| Event Detect Period 2 (7 hr) Hydrophone | 0 | 3 |
| Event Detect Period 3 (7 hr) Vertical Seismometer | 17 | 5 |

On both instruments, the vast majority of triggers occurred during the first period of event detection. These triggers were mostly the result of swarms of small impulsive events which have previously been attributed to either cracking or fish bumps. These events (Figures 5-6) are observed only on the seismometer channels and it is not possible to identify P and S waves. The swarms were particularly intense on the axial OBS which triggered more frequently than the off-axis OBS despite a higher trigger ratio. During a 3-4 hour period both OBSs triggered repeatedly and smaller swarms were also recorded at other times (Figure 7). Although the swarms occurred at similar times on both instruments, a cursory inspection of the data shows that many of the individual events are

not common to both OBSs. One of our first analysis tasks will be to systematically determine whether common sequences of larger events can be identified on both instruments.

About 15-20 small earthquakes were recorded on OBS 62 with clearly discernible P, S, water multiple, and T phases (Figures 8-10). The differential S-P time for these events is 1.5-2 s which suggests a range of 20-25 km. Since the two OBSs were only 5 km apart it is somewhat surprising that none of these events triggered the axial OBS. The most obvious explanation is that the trigger ratio on the axial instrument was too high to trigger on these events. Several earthquakes on OBS 62 did occur during periods when OBS 58 was recording swarm activity. Since the earthquakes are not clearly discernible in these records and the background noise levels are similar for both OBSs, the earthquakes must either have been obliterated by the swarm events or they must have traveled along an attenuating path.

Only three records were recorded during the period of hydrophone triggering, a result that can be easily understood from inspection of records obtained during other periods. The swarm events (Figures 5-6) are not observed on the hydrophone channel. P waves for the earthquakes (Figures 8-9) are observable on the hydrophone, but these events are so impulsive that they are insufficient to increase the RMS amplitude of a 1 second window to the trigger threshold. The impulsive characteristics of the P wave from small events have almost certainly been enhanced by the new filters added to the OBS for this experiment.

| Event Name | OBS 58 | OBS 62 | Hydrophone |
|-----------------|--------|--------|------------|
| Event 1 (Small) | 1 | 1 | 0 |
| Event 2 (Small) | 1 | 1 | 0 |
| Event 3 (Small) | 1 | 1 | 0 |

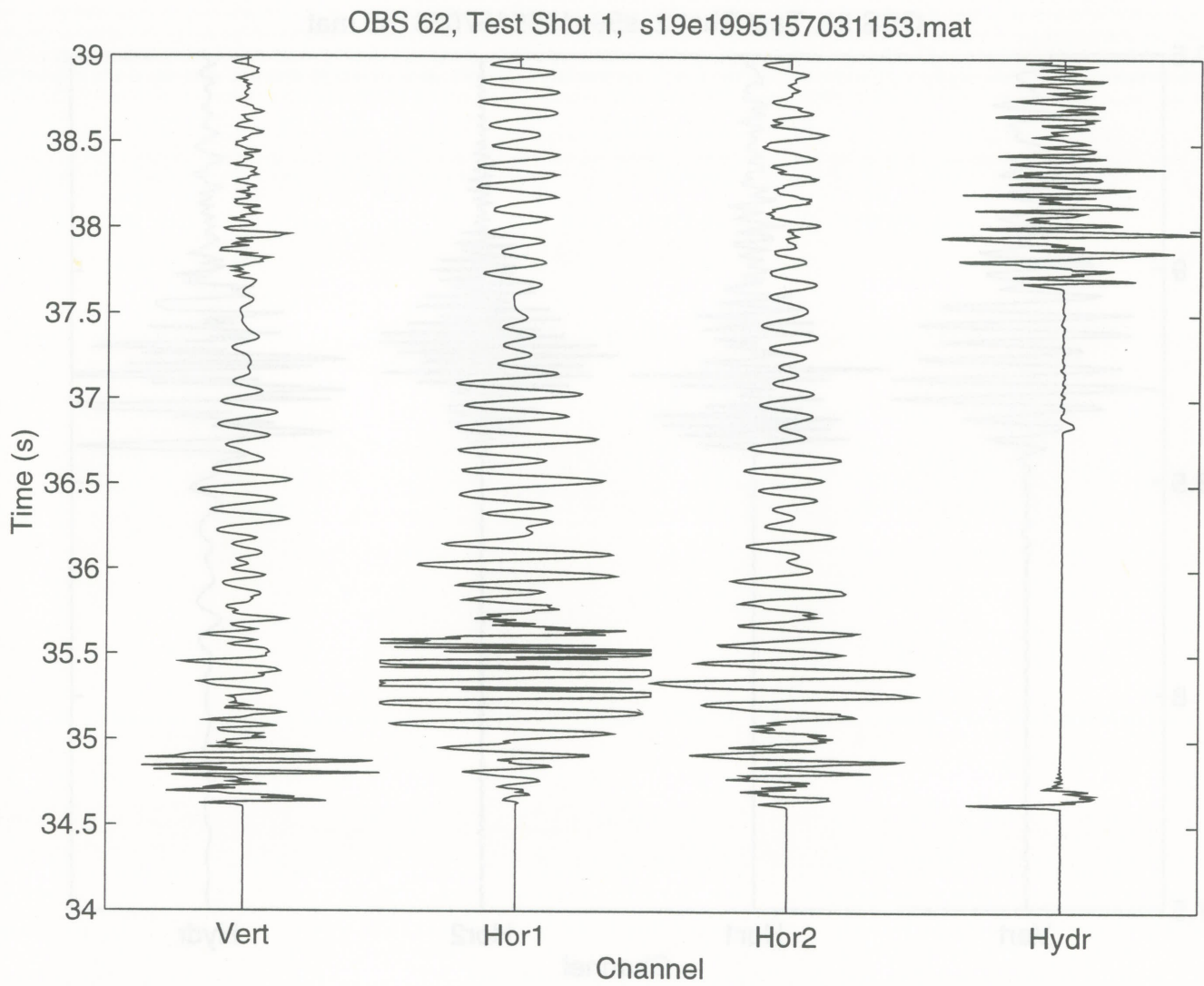


Figure 2. Records for test shot 1 which was fired immediately above OBS 62.

OBS 58, Test Shot 2, s59e1995157033149.mat

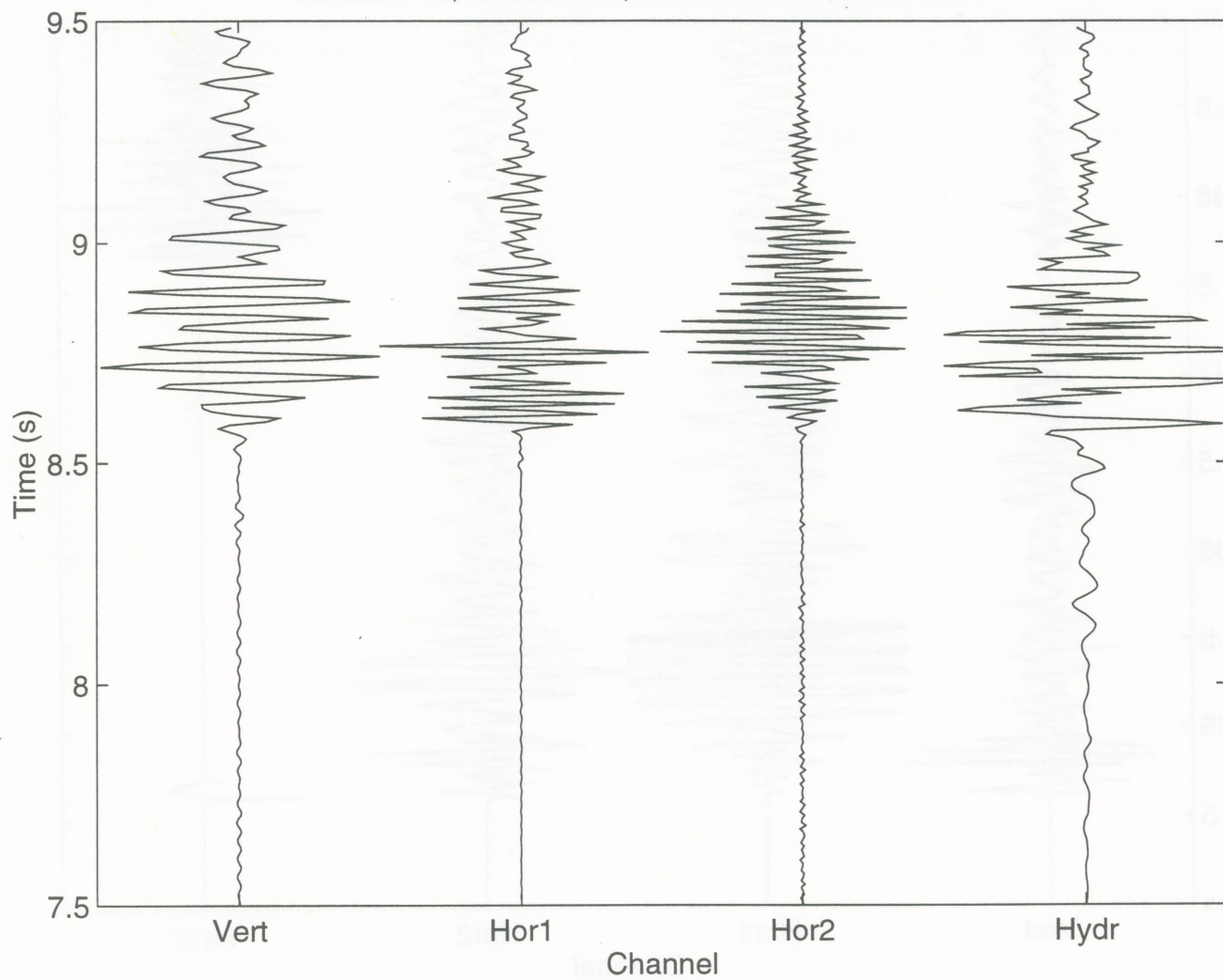


Figure 3. Records for test shot 2 fired 5 km to the west of OBS 58.

OBS 62, Test Shot 3, s19e1995157035001.mat

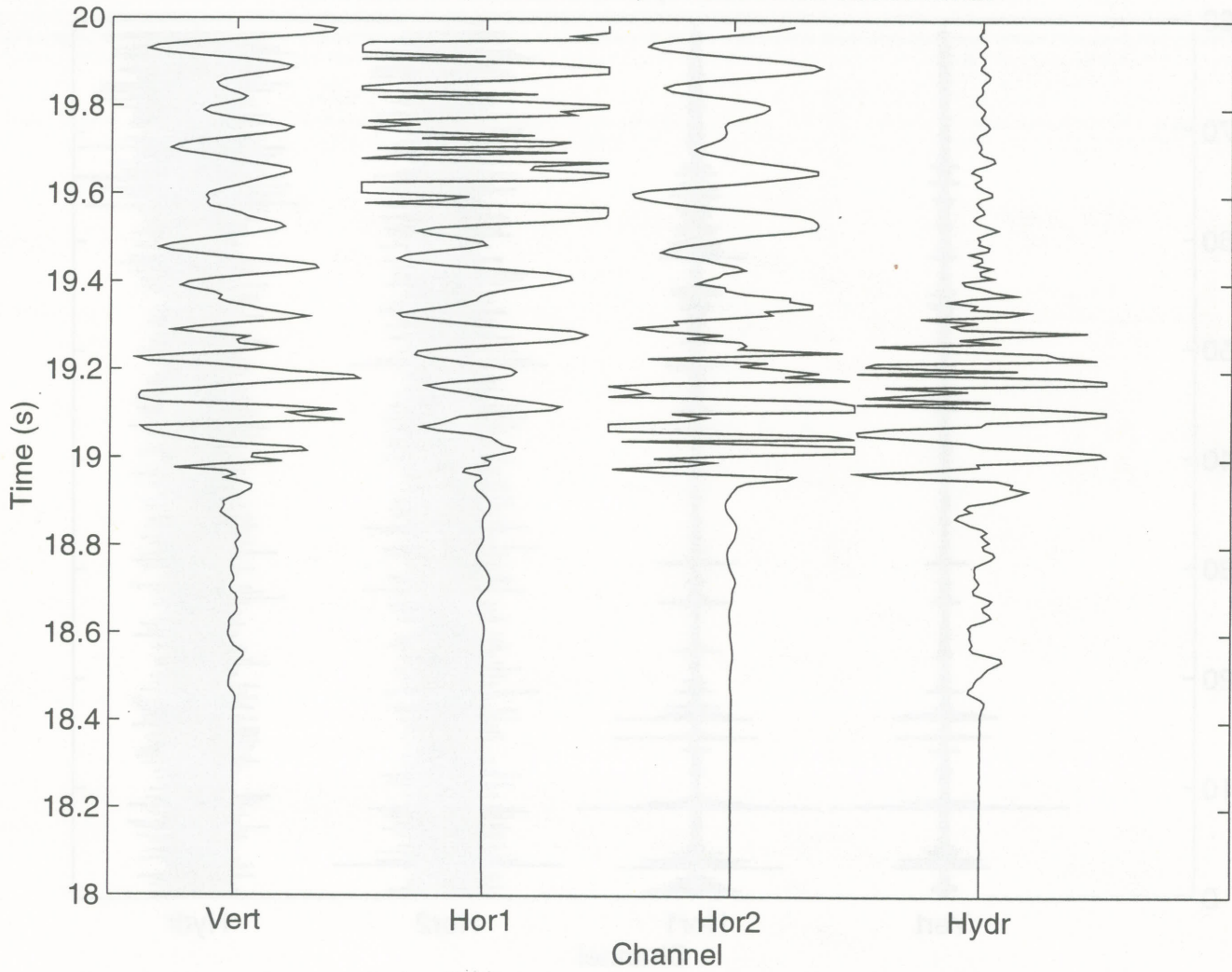


Figure 4. Records from test shot 3 fired 4 km to the west of OBS 62.

OBS 58, Swarm Activity, s59e1995157013509.mat

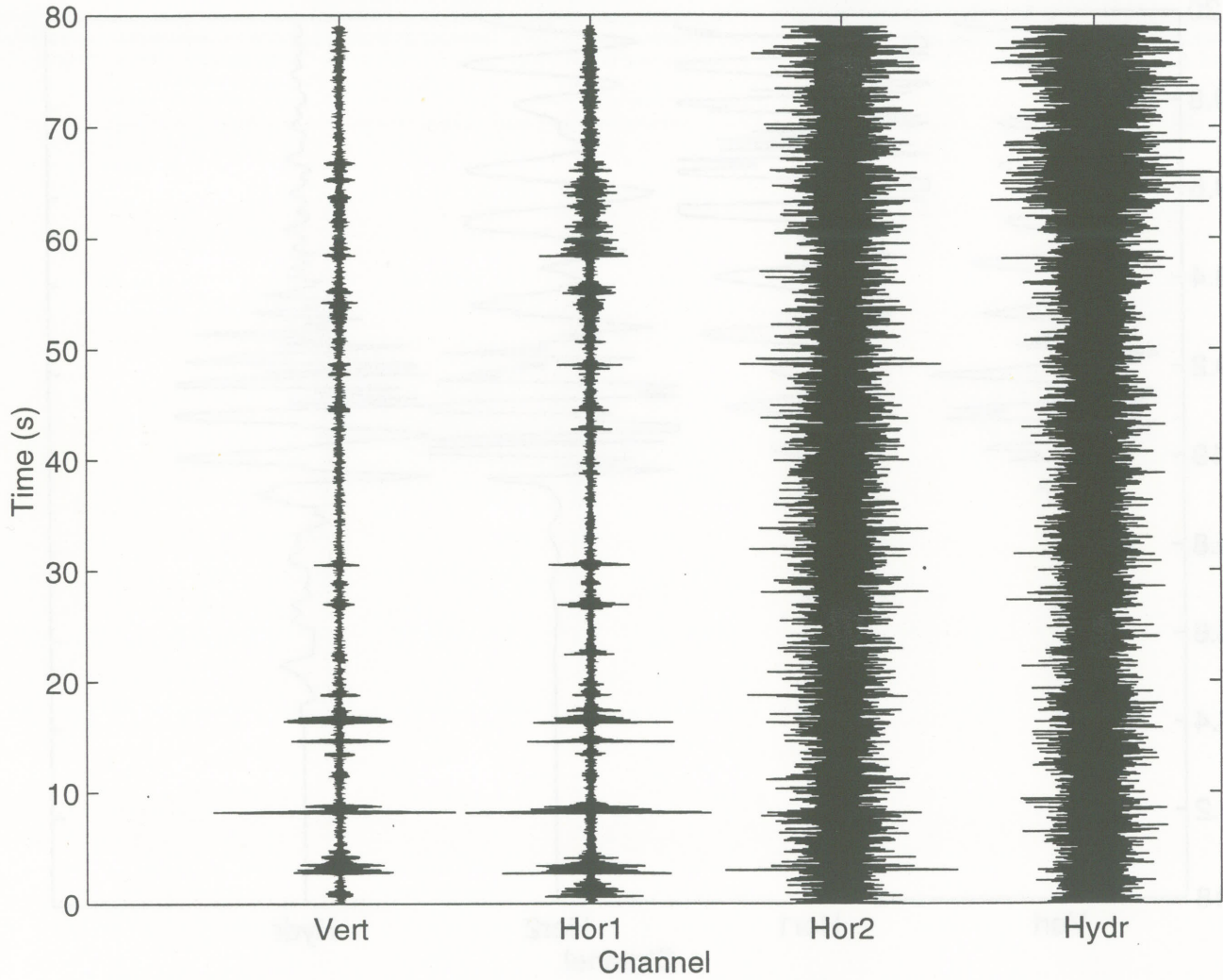


Figure 5. A swarm sequence on the axial OBS 58.

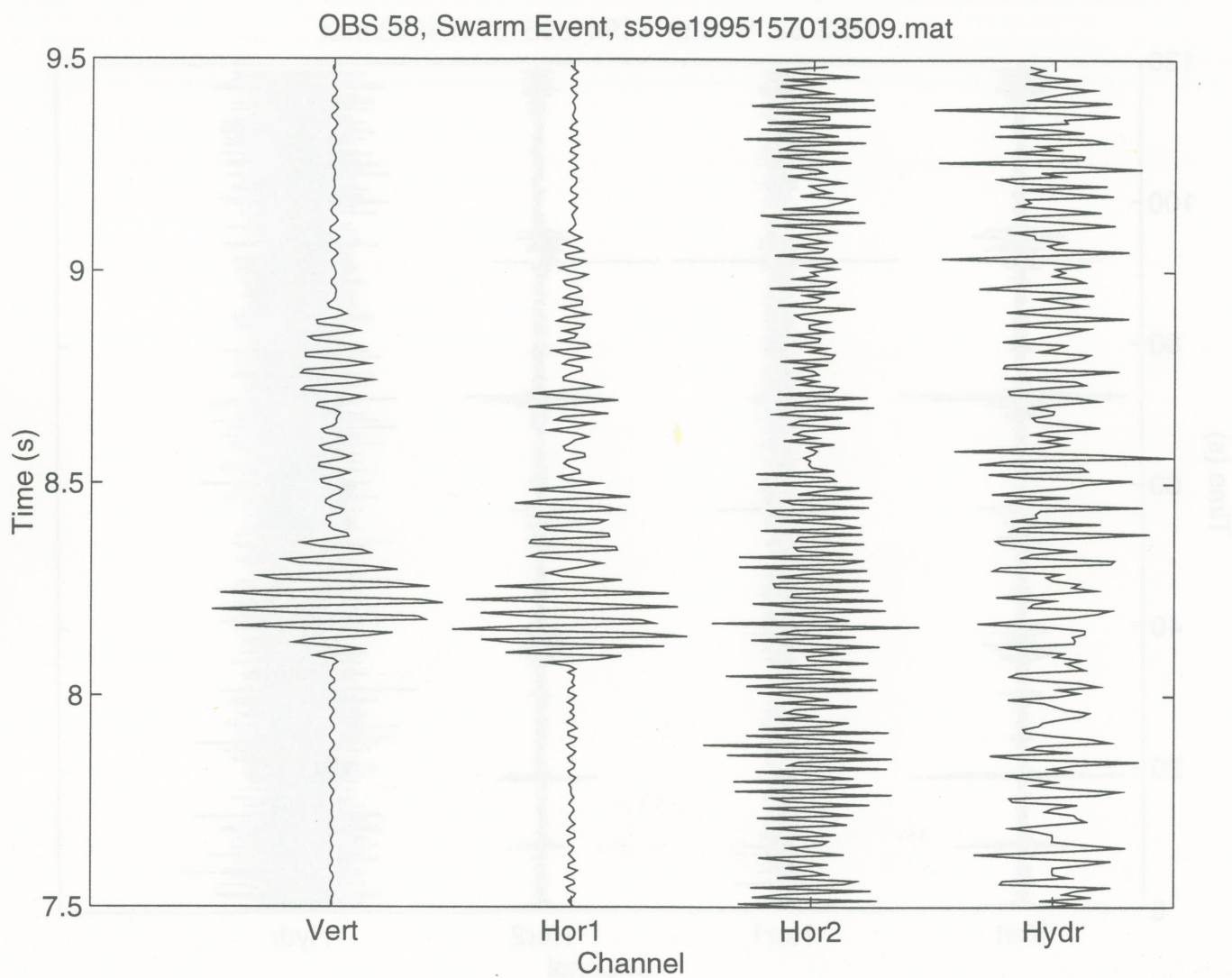


Figure 6. A swarm event on the axial OBS 58.

OBS 62, Swarm s19e1995157023858.mat

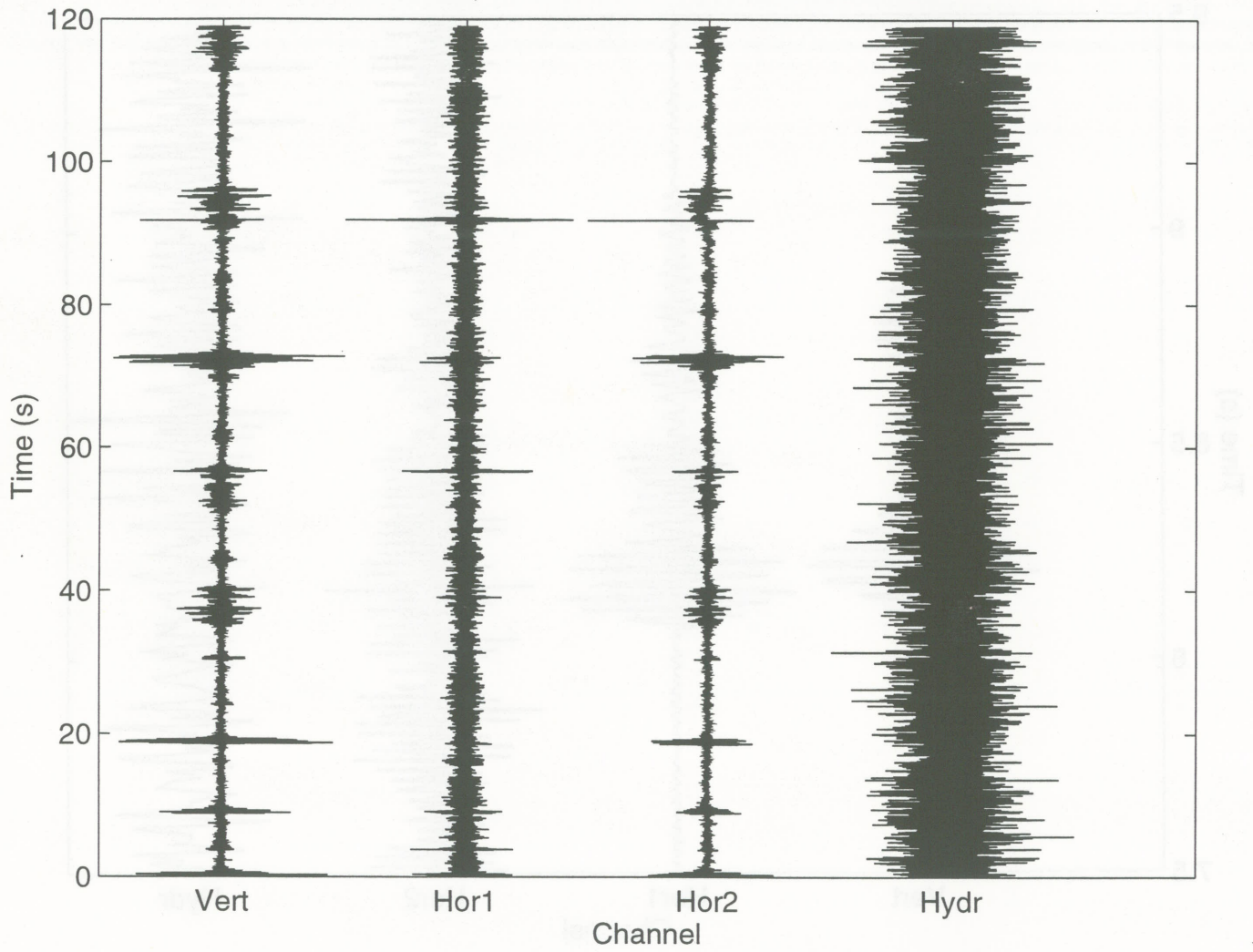


Figure 7. A swarm sequence on the off-axis OBS 62.

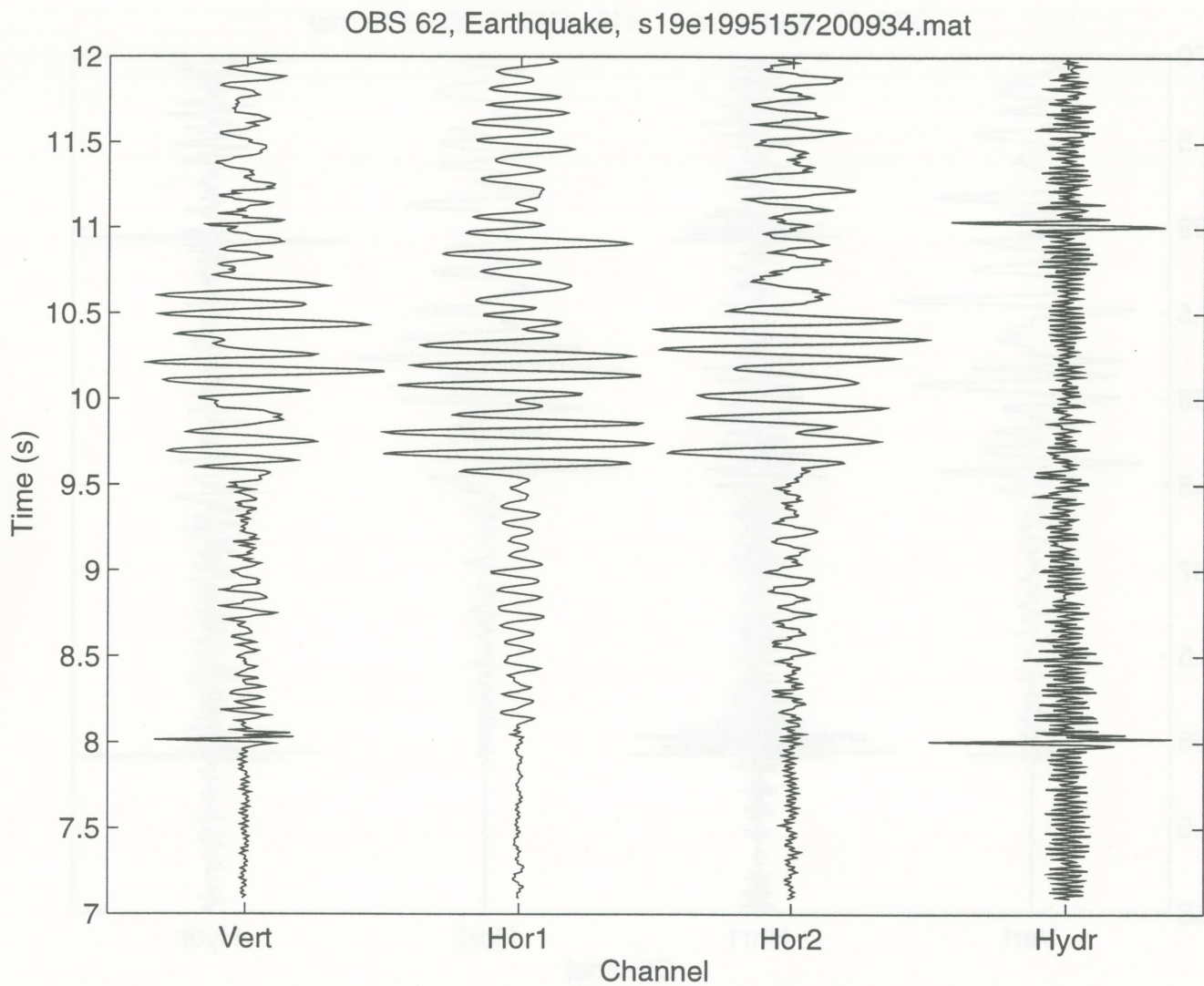


Figure 8. An impulsive earthquake recorded on OBS 62. The P wave arrival time is ~ 8 s, the S wave arrival time ~9.5 s, and the first water multiple on the hydrophone is at ~11 s.

OBS 62, Earthquake, s19e1995157001619.mat

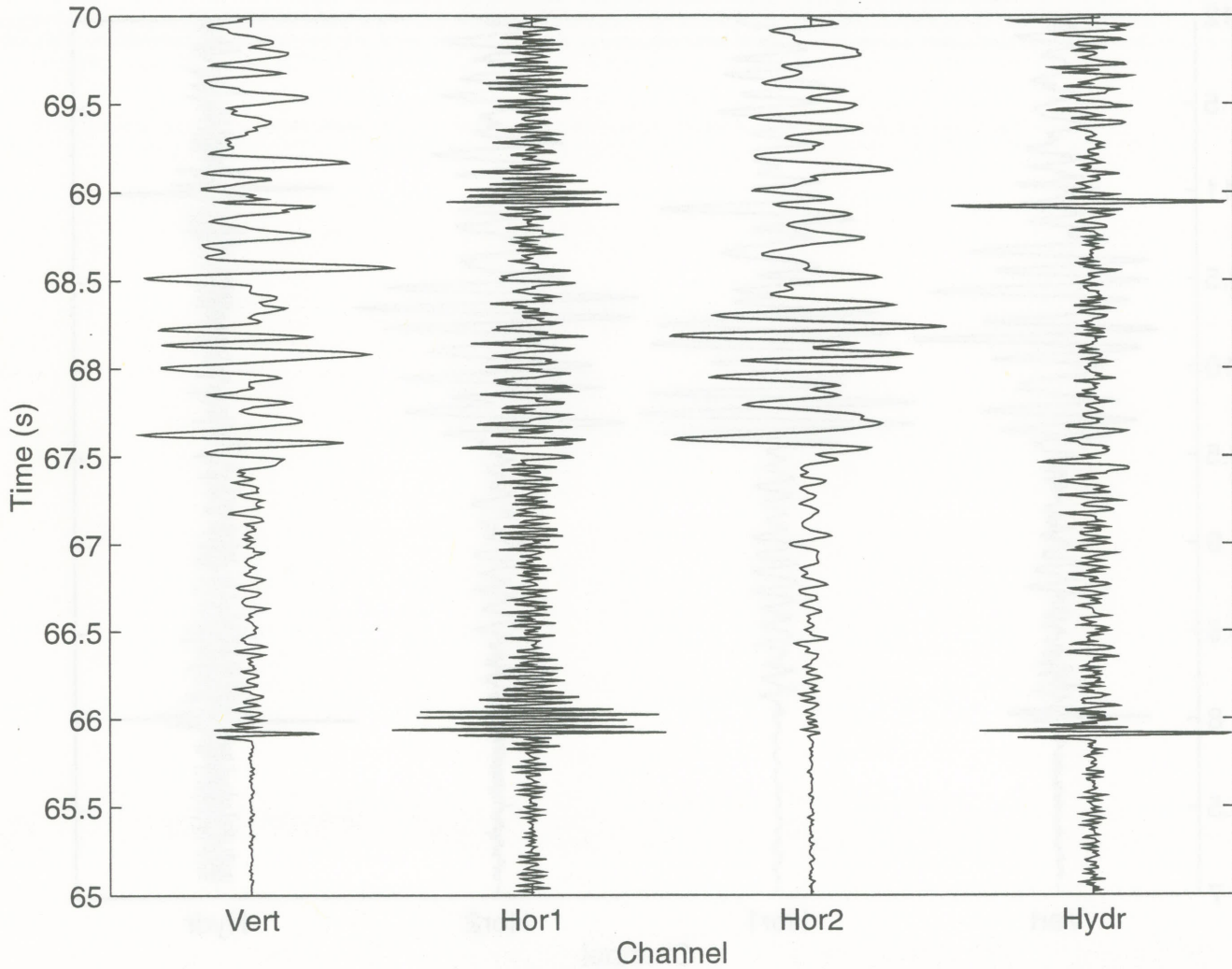


Figure 9. Another impulsive earthquake recorded on OBS 62. The P wave arrival time is ~ 66 s, the S wave arrival time ~67.5, and the first water multiple on the hydrophone is at 69 s.

OBS 62, Emergent Earthquake, s19e1995157041032.mat

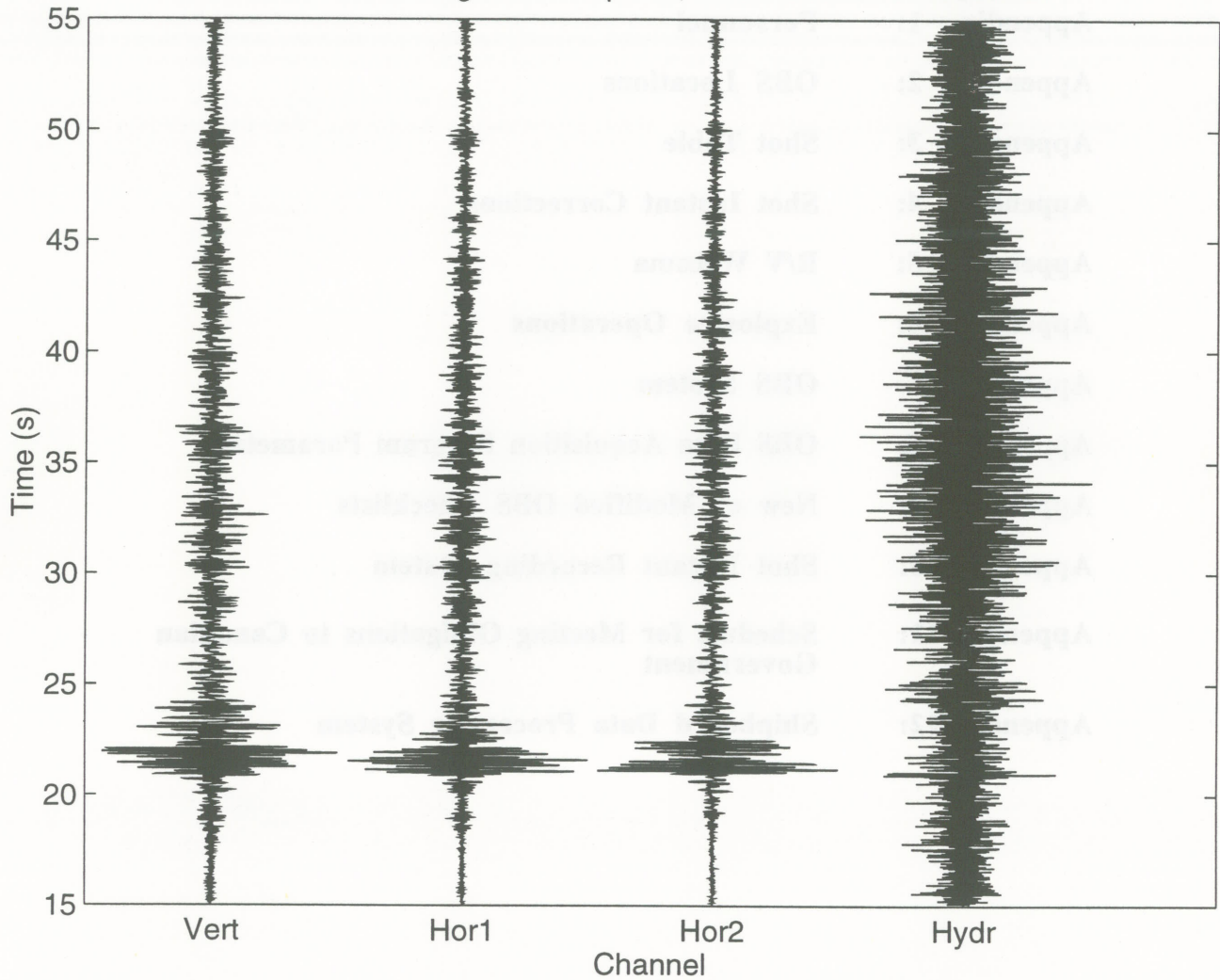


Figure 10. An emergent earthquake recorded on OBS 62 showing a small T phase at 30-45 s on the hydrophone channel.

Appendices

- Appendix 1: Personnel**
- Appendix 2: OBS Locations**
- Appendix 3: Shot Table**
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- Appendix 7: OBS System**
- Appendix 8: OBS Data Acquisition Program Parameters**
- Appendix 9: New or Modified OBS Checklists**
- Appendix 10: Shot Instant Recording System**
- Appendix 11: Schedule for Meeting Obligations to Canadian Government**
- Appendix 12: Shipboard Data Processing System**

Appendix 1: Personnel

Science Complement

| | |
|----------------|--|
| W.S.D. Wilcock | Chief Scientist, University of Washington |
| S. Archer | Graduate Student, University of Washington |
| J. Bailey | Technician, WHOI |
| J. Dolan | Technician, WHOI |
| D. DuBois | Technician, WHOI |
| J. Hallinan | Engineer, WHOI |
| G. M. Purdy | Co-Chief Scientist, WHOI |
| F. B. Wooding | Engineer, WHOI |
| M. Willis | OSU Marine technician |
| R. Bower | OSU Electrical Technician |

Officers and Crew

| | |
|-----------------|--------------------|
| E. J. Doyle | Master |
| M. Jenkins | Chief Mate |
| M.D.Estey | 2nd Mate |
| J.R.Keiper | Bos'n |
| R. Torgeson | A/B |
| R. E. Guillory | A/B |
| R. Deer | A/B |
| J. Walters | Chief Engineer |
| D. C. Leafdahl | Assistant Engineer |
| R. Hassman | QMED |
| R. L. Searls | Cook/Steward |
| R. G. Schroeder | Messman |

Appendix 2: OBS Locations

OBS DEPLOYMENT TABLE
(Test Deployment)

| OBS # | mo/dy/Time Deployed (UT) | Water Depth (corr. m) | Latitude | Longitude |
|-------|-----------------------------|--------------------------|-------------|--------------|
| 62 | 6/5/2052 | 2325 | 47° 57.97'N | 129° 09.71'W |
| 58 | 6/5/2212 | 2250 | 47° 56.64'N | 129° 5.89'W |

OBS RECOVERY TABLE
(Test Deployment)

| OBS # | mo/dy/Time Recovered (UT) | Latitude | Longitude |
|-------|------------------------------|-------------|--------------|
| 62 | 6/7/0106 | 47° 57.90'N | 129° 09.74'W |
| 58 | 6/7/0335 | 47° 56.58'N | 129° 05.89'W |

OBS DEPLOYMENT TABLE
(Main Experiment)

| OBS # | mo/dy/Time Deployed (UT) | Water Depth (corr. m) | Latitude | Longitude |
|-------|-----------------------------|--------------------------|-------------|--------------|
| 58 | 6/7/2028 | 2365 | 48° 00.04'N | 129° 07.87'W |
| 62 | 6/7/2157 | 2315 | 47° 56.12'N | 129° 10.68'W |
| 61 | 6/7/2259 | 2545 | 47° 58.84'N | 129° 12.59'W |
| 52 | 6/8/0036 | 2220 | 47° 57.28'N | 129° 05.39'W |
| 56 | 6/8/0158 | 2225 | 47° 56.70'N | 129° 05.75'W |
| 64 | 6/8/0247 | 2100 | 47° 57.12'N | 129° 06.27'W |
| 55 | 6/8/0339 | 2135 | 47° 55.55'N | 129° 05.46'W |
| 51 | 6/8/1743 | 2525 | 48° 01.07'N | 129° 15.02'W |
| 63 | 6/8/1955 | 2320 | 47° 58.08'N | 129° 09.52'W |
| 60 | 6/8/2050 | 2590 | 47° 56.90'N | 129° 13.99'W |
| 59 | 6/8/2141 | 2490 | 47° 58.50'N | 129° 16.83'W |
| 54 | 6/8/2231 | 2445 | 48° 00.96'N | 129° 11.38'W |
| 53 | 6/8/2329 | 2100 | 47° 58.88'N | 129° 05.72'W |
| 57 | 6/9/0017 | 2120 | 47° 58.10'N | 129° 04.42'W |
| 50 | 6/9/0138 | 2200 | 47° 56.24'N | 129° 06.83'W |

Appendix 3: Shot Table

| Date mo/dy | Shot # | Size (lbs) | Overside Time (UT) (hrmin:s) | Uncorr Shot Time (UT) (hrmin:s) | Burn Time (s) | Bbl Pd (ms) | Spd kts | Latitude N | Longitude W | Shot Depth (m) | SI corr (s) | Corrected Shot Time (hrmin:s) |
|---------------|-----------|---------------|------------------------------------|---------------------------------------|---------------------|-------------------|------------|---------------|----------------|----------------------|-------------------|-------------------------------------|
| 6/06 | T1 | 10 | 0311:01.601 | 0312:07.367 | 65.8 | 92 | 11.0** | Over OBS #62 | | 68.4 | 0.211 | 0312:07.156 |
| 6/06 | T2 | 10 | 0330:47.218 | 0331:49.960 | 62.7 | 96 | 11.0** | 47°57.91' | 129°09.67' | 64.5 | 0.199 | 0331:49.761 |
| 6/06 | T3 | 10 | 0349:00.997 | 0350:06.262 | 65.3 | 95 | 11.0** | 47°59.21' | 129°11.06' | 65.5 | 0.209 | 0350:06.053 |
| 6/10 | 1 | 10 | 0118:49.983 | 0119:54.501 | 64.5 | 98 | 10.2 | 48°00.78' | 129°18.59' | 62.7 | 0.188 | 0119:54.313 |
| 6/10 | 2 | 10 | 0226:57.369 | 0228:01.933 | 64.6 | 101 | 10.6 | 47°57.49' | 129°18.91' | 60.1 | 0.197 | 0228:01.736 |
| 6/10 | 3 | 10 | 0234:55.451 | 0236:01.457 | 66.0 | 94 | 10.8 | 47°59.02' | 129°18.92' | 66.4 | 0.207 | 0236:01.250 |
| 6/10 | 4 | 10 | 0253:21.148 | 0254:24.636 | 63.5 | 98 | 10.9 | 48°02.12' | 129°17.96' | 62.7 | 0.200 | 0254:24.436 |
| 6/10 | 5 | 10 | 0415:09.672 | 0416:13.268 | 63.6 | 104 | 10.5 | 47°56.04' | 129°16.50' | 57.7 | 0.191 | 0416:13.077 |
| 6/10 | 6 | 10 | 0428:04.439 | 0429:08.406 | 64.0 | 96 | 11.2 | 47°58.55' | 129°16.89' | 64.5 | 0.208 | 0429:08.198 |
| 6/10 | 7 | 10 | 0435:16.321 | 0436:24.652 | 68.3 | 91* | 10.9 | 47°59.61' | 129°15.88' | 69.5 | 0.218 | 0436:24.434 |
| 6/10 | 8 | 10 | 0444:56.161 | 0446:00.963 | 64.8 | 97 | 11.4 | 48°01.14' | 129°15.01' | 63.6 | 0.215 | 0446:00.748 |
| 6/10 | 9 | 10 | 0619:36.467 | 0620:39.157 | 62.7 | 101* | 11.2 | 47°55.41' | 129°13.90' | 60.1 | 0.203 | 0620:38.954 |
| 6/10 | 10 | 10 | 0627:48.801 | DUD | | | 11.1 | 47°56.94' | 129°13.98' | | | |
| 6/10 | 11 | 10 | 0637:18.926 | 0638:22.673 | 63.7 | 100 | 11.0 | 47°57.65' | 129°15.21' | 61.0 | 0.202 | 0638:22.471 |
| 6/10 | 12 | 10 | 0644:46.322 | 0645:51.743 | 65.4 | 96 | 11.1 | 47°58.61' | 129°14.39' | 64.5 | 0.211 | 0645:51.532 |
| 6/10 | 13 | 10 | 0650:09.820 | 0651:14.961 | 65.1 | 96 | 11.4 | 47°59.53' | 129°13.92' | 64.5 | 0.217 | 0651:14.744 |
| 6/10 | 14 | 10 | 0657:42.072 | DUD | | | 11.1 | 48°00.82' | 129°13.08' | | | |
| 6/10 | 15 | 10 | 0705:55.885 | 0707:03.375 | 67.5 | 94 | 11.3 | 48°02.32' | 129°13.39' | 66.4 | 0.224 | 0707:03.151 |
| 6/10 | 16 | 10 | 1507:40.708 | 1508:44.898 | 64.2 | ** | 12.0 | 47°54.91' | 129°11.06' | 64.5** | 0.226 | 1508:44.672 |
| 6/10 | 17 | 10 | 1530:12.042 | 1531:13.540 | 61.5 | 99* | 12.3 | 47°58.90' | 129°12.60' | 61.8 | 0.221 | 1531:13.319 |
| 6/10 | 18 | 10 | 1536:32.829 | 1537:33.390 | 60.6 | 103 | 11.6 | 47°00.02' | 129°12.00' | 58.5 | 0.203 | 1537:33.187 |
| 6/10 | 19 | 10 | 1542:01.519 | 1543:02.975 | 61.5 | 99* | 12.1 | 48°00.98' | 129°11.44' | 61.8 | 0.217 | 1543:02.758 |
| 6/10 | 20 | 10 | 1549:00.356 | 1550:00.761 | 60.4 | 101 | 11.8 | 48°02.28' | 129°10.83' | 60.1 | 0.206 | 1550:00.555 |
| 6/10 | 21 | 10 | 1601:13.109 | 1602:13.412 | 60.3 | 104 | 11.2 | 48°01.48' | 129°08.49' | 57.7 | 0.193 | 1602:13.219 |
| 6/10 | 22 | 10 | 1611:28.088 | 1612:28.868 | 60.8 | 104 | 11.4 | 48°00.81' | 129°05.87' | 57.7 | 0.199 | 1612:28.669 |
| 6/10 | 23 | 10 | 1623:05.107 | 1624:05.696 | 60.6 | 100* | 10.6 | 48°00.07' | 129°07.92' | 61.0 | 0.183 | 1624:05.513 |
| 6/10 | 24 | 10 | 1631:19.888 | 1632:21.515 | 61.6 | 102* | 11.4 | 48°00.38' | 129°10.24' | 59.3 | 0.203 | 1632:21.313 |
| 6/10 | 25 | 10 | 1703:10.039 | 1704:11.404 | 61.4 | 99* | 9.0 | 48°00.74' | 129°13.10' | 61.8 | 0.153 | 1704:11.251 |
| 6/10 | 26 | 10 | 1724:54.697 | 1725:55.820 | 61.1 | 100* | 9.0 | 47°56.87' | 129°14.00' | 61.0 | 0.152 | 1725:55.668 |
| 6/10 | 27 | 10 | 2353:07.983 | 2354:09.671 | 61.7 | 102 | 12.1 | 47°56.15' | 129°10.65' | 59.3 | 0.217 | 2354:09.454 |

Shot Table (continued)

| Date mo/dy | Shot # | Size (lbs) | Overside Time (UT) (hrmin:s) | Uncorr Shot Time (UT) (hrmin:s) | Burn Time (s) | Bbl Pd (ms) | Spd kts | Latitude N | Longitude W | Shot Depth (m) | SI corr (s) | Corrected Shot Time (hrmin:s) |
|---------------|-----------|---------------|------------------------------------|---------------------------------------|---------------------|-------------------|------------|---------------|----------------|----------------------|-------------------|-------------------------------------|
| 6/10 | 28 | 10 | 2359:24.097 | 0000:25.729 | 61.6 | 102 | 11.9 | 47°57.33' | 129°11.25' | 59.3 | 0.213 | 0000:25.516 |
| 6/11 | 29 | 10 | 0006:07.746 | 0007:09.000 | 61.3 | 101 | 12.0 | 47°58.53' | 129°10.94' | 60.1 | 0.214 | 0007:08.786 |
| 6/11 | 30 | 10 | 0012:35.958 | 0013:40.273 | 64.3 | 108 | 12.1 | 47°59.44' | 129°09.60' | 54.7 | 0.225 | 0013:40.048 |
| 6/11 | 31 | 10 | 0025:49.471 | 0026:52.640 | 63.2 | 101 | 11.9 | 47°58.09' | 129°09.55' | 60.1 | 0.219 | 0026:52.421 |
| 6/11 | 32 | 10 | 0033:07.716 | 0034:09.045 | 61.3 | 101 | 11.8 | 47°56.82' | 129°08.78' | 60.1 | 0.210 | 0034:08.835 |
| 6/11 | 33 | 10 | 0041:40.826 | 0042:39.350 | 58.5 | 106 | 11.5 | 47°55.21' | 129°08.68' | 56.2 | 0.192 | 0042:39.158 |
| 6/11 | 34 | 10 | 0118:33.121 | 0119:34.435 | 61.3 | 102 | 12.0 | 47°54.60' | 129°06.27' | 59.3 | 0.214 | 0119:34.221 |
| 6/11 | 35 | 10 | 0128:29.164 | 0129:29.157 | 60.0 | 104 | 11.8 | 47°56.25' | 129°06.85' | 57.7 | 0.204 | 0129:28.953 |
| 6/11 | 36 | 10 | 0135:47.034 | 0136:56.901 | 69.9 | 90 | 11.8 | 47°57.56' | 129°07.64' | 70.5 | 0.245 | 0136:56.656 |
| 6/11 | 37 | 10 | 0142:15.556 | 0143:14.819 | 59.3 | 103 | 12.0 | 47°58.76' | 129°07.52' | 58.5 | 0.206 | 0143:14.613 |
| 6/11 | 38 | 10 | 0152:32.619 | 0153:37.436 | 64.8 | 95 | 10.7 | 47°58.34' | 129°05.74' | 65.5 | 0.200 | 0153:37.236 |
| 6/11 | 39 | 10 | 0200:29.837 | 0201:35.785 | 65.9 | 95 | 11.1 | 47°57.15' | 129°06.28' | 65.5 | 0.213 | 0201:35.572 |
| 6/11 | 40 | 10 | 0210:34.029 | 0211:45.862 | 71.8 | 91 | 11.5 | 47°55.57' | 129°05.49' | 69.5 | 0.245 | 0211:45.617 |
| 6/11 | 41 | 10 | 0221:36.630 | 0222:42.954 | 66.3 | 96 | 12.2 | 47°54.91' | 129°03.74' | 64.5 | 0.239 | 0222:42.715 |
| 6/11 | 42 | 10 | 0229:09.393 | 0230:19.331 | 69.9 | 93 | 12.0 | 47°56.30' | 129°02.90' | 67.4 | 0.250 | 0230:19.082 |
| 6/11 | 43 | 10 | 0236:17.557 | 0237:26.134 | 68.6 | 94 | 12.0 | 47°57.64' | 129°02.88' | 66.4 | 0.244 | 0237:25.890 |
| 6/11 | 44 | 10 | 0243:24.253 | 0244:27.696 | 63.4 | 102 | 11.9 | 47°59.01' | 129°03.30' | 59.3 | 0.220 | 0244:27.476 |
| 6/11 | 45 | 10 | 0253:24.632 | 0254:38.306 | 73.7 | 89 | 11.0 | 47°58.06' | 129°04.40' | 71.6 | 0.241 | 0254:38.065 |
| 6/11 | 46 | 10 | 0301:07.441 | 0302:11.067 | 63.6 | 101 | 11.2 | 47°56.66' | 129°04.91' | 60.1 | 0.206 | 0302:10.861 |
| 6/11 | 47 | 10 | 0309:55.939 | 0310:55.872 | 59.9 | 103 | 11.8 | 47°56.76' | 129°06.50' | 58.5 | 0.204 | 0310:55.668 |
| 6/11 | 48 | 10 | 0318:05.246 | 0319:14.827 | 68.6 | 96 | 11.6 | 47°58.00' | 129°05.77' | 64.5 | 0.235 | 0319:14.592 |
| 6/11 | 49 | 10 | 0326:48.689 | 0328:03.341 | 74.7 | 90 | 12.1 | 47°59.57' | 129°04.95' | 70.5 | 0.272 | 0328:03.069 |
| 6/11 | 50 | 10 | 0342:49.175 | 0344:04.371 | 75.2 | 87 | 11.5 | 47°57.42' | 129°04.66' | 73.9 | 0.259 | 0344:04.112 |
| 6/11 | 51 | 15 | 0419:47.187 | 0420:46.892 | 59.7 | 186 | 12.0 | 47°57.99' | 129°13.03' | 29.6 | 0.204 | 0420:46.688 |

* = Bubble pulse period read from oscilloscope

** = Missed observation, value estimated.

Shot instants recorded as described in Appendix 10.

Shot instant corrections computed as described in Appendix 4.

Appendix 4: Shot Instant Corrections

The charge depth is calculated from the knowledge of the bubble pulse period using the classic relationship:

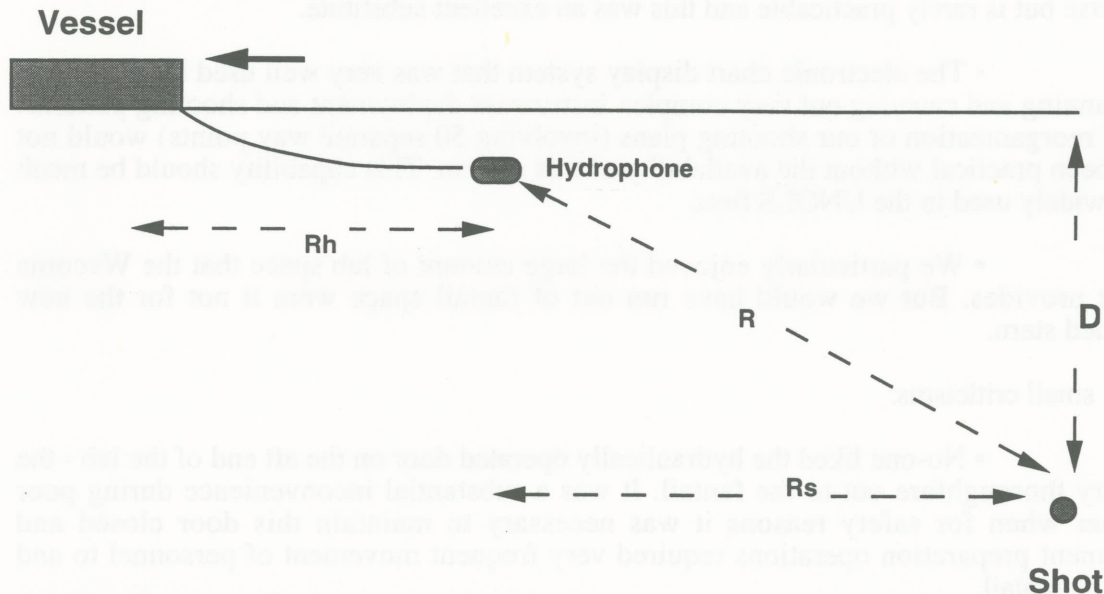
$$\text{Bubble Pulse Period} = \{\text{const} * W^{1/3}\} / \{H + 33\}^{5/6}$$

Where W is the weight in lbs, H is the depth in feet, the bubble pulse period is in seconds and the empirically determined constants are:

| | |
|-----------|------|
| For TNT | 4.36 |
| For Tovex | 5.06 |
| For NIT-S | 4.03 |

Rearranging the above equation to solve for depth (D) and changing the units to meters, and substituting the constant for TNT and assuming a 10lb charge weight results in:

$$D = \{14.702 / (\text{BP})^{1.2} - 33\} * 0.3048 \text{ meters}$$



The distance of the shot aft of the towed hydrophone at the time of detonation (R_s)

$$= \{\text{Burntime} * \text{ships speed (m/s)}\} - R_h \text{ (separation of hydrophone and shot table (m))}$$

(The conversion factor from knots to m/s is $*0.514$)

(On this cruise on the WECOMA the measured separation of the hydrophone and the shot table was 63m)

The shot instant correction (to be subtracted from the absolute recorded shot time) is then:

$$= R / 1500 \text{ seconds}$$

$$= \{[D^2 + R_s^2]^{0.5}\} / 1500 \text{ seconds}$$

Appendix 5: R/V Wecoma

All objectives of the cruise were met, no substantial difficulties were experienced with any aspect of the ship operations despite some difficult weather conditions and requirements for accurate ship positioning. We received total co-operation from the ship's officers and crew (Appendix 1) and the quality of the ship handling and navigation was excellent. We always enjoy sailing on this class (Oceanus, Endeavour, Wecoma) of vessel. They are an ideal size for this type of experiment and are sufficiently seaworthy to be able to work effectively in all but the most extreme conditions.

We received outstanding shoreside support, particularly from marine Superintendent Fred Jones who helped greatly with all the tedium associated with clearances and regulations related to the loading and use of explosives.

The positive attributes of Wecoma herself were:

- Good quality TV coverage of the fantail allowed monitoring of operations from the lab even in the worst weather conditions. Direct line of sight is always preferable of course but is rarely practicable and this was an excellent substitute.

- The electronic chart display system that was very well used by the bridge for planning and carrying out very complex instrument deployment and shooting patterns. Rapid reorganization of our shooting plans (involving 50 separate way points) would not have been practical without the availability of this system. This capability should be much more widely used in the UNOLS fleet.

- We particularly enjoyed the large amount of lab space that the Wecoma layout provides. But we would have run out of fantail space were it not for the new extended stern.

A few small criticisms:

- No-one liked the hydraulically operated door on the aft end of the lab - the primary thoroughfare out to the fantail. It was a substantial inconvenience during poor weather when for safety reasons it was necessary to maintain this door closed and instrument preparation operations required very frequent movement of personnel to and from the fantail.

- The loss of the small deck crane half way through the cruise was disappointing - it is so much more convenient to use than the main crane. The ship deserves a new one!

- During shooting operations we arrived at an excellent solution to the fantail-lab-bridge communication issue by having one of the ship's intercoms installed on the fantail. But we could have done the same much more simply with handheld VHF sets - but the vessel had only one operating unit. A vessel of Wecoma's size and capability should carry three or four handheld VHF's. They are invaluable communication tools in many situations.

- We were surprised by the requirement to shut down all our systems during shore-to-ship power switchovers. Nowadays we rarely have to do that - a small inconvenience.

Appendix 6: Explosive Operations

A total of 540 lbs of Pentolyte in the form of 5 lb boosters was loaded in Newport along with 500' of 150 grain Primacord, 500' 70 grain Primacord and 200 #8 detonators. A record of all shot locations and times is provided in Appendix 3 and a description of the new shot instant recording system (that performed very well) is given in Appendix 10.

Explosive charges fired on the cruise consisted of ten pounds of Pentolyte produced by combining two *TROJAN* 5-pound boosters. The boosters were taped side by side, and four feet of 150-grain PETN detonator cord was threaded through them and knotted. The cord was initiated by #8 *NOBEL* fuse type detonators. Fuse lengths of 26 inches yielded burn times in the range of 62 to 67 seconds.

Failure of two charges to detonate early in the cruise prompted the doubling of the detonators, each having its own fuse. In addition, the knot in the detonator cord was deleted in order to eliminate any chance of cord being cut off at crossing points. No further duds were experienced.

Because all the charges were detonated within a small area (less than 10 n.m. square) and because the vessel steamed repeatedly through this area an unusual opportunity was afforded to observe any detrimental effects of the shooting operations on marine life. No impact was observed.

Appendix 7: OBS System

In this Appendix we present four sections pertaining to the operation of the ONR OBS system during this cruise. The first is a Table that lists all the ID numbers of the various component parts of each OBS, which are, as always identified by their frame numbers. The second presents the pre-deployment and post recovery clock synchronization data for the short one-day-long test deployment. The third is a Table of the pre-deployment clock checks for the main experiment; and finally we present a section of text that describes particular occurrences of interest and discusses a number of possible improvements that could be made in the instruments.

Because of the expected rough terrain near the ridge axis for all 16 deployments of the conventional ONR OBS (i.e. all except the one-year instrument) that were carried out on this cruise the instruments were rigged to float approximately 1-2' above their anchors, in a refined version of the 'FARA-mode' developed to successfully overcome the problems caused by the extreme topography of the Mid-Atlantic Ridge.. The sensor deployment arm release, and the separation of the sensor from the deployment arm were achieved using soluble sugar releases. The activation of these releases was by chance observed on OBS #62 during the test deployment, at times of 2 hours 34 mins and 2 hours 44 mins, respectively, after launch.

OBS Electronics Configuration for Juan de Fuca Experiment

| OBS Frame S/N | Acq. S/N | Clock S/N | Rec. S/N | Geo. S/N | Hydro. S/N | Hydro. Preamp. S/N | Serial Cable S/N | Hydro. Preamp. Cable S/N | Hydro. Cable S/N | Geo. Cable S/N | Disk 1 (Bottom) S/N | Disk 2 (Top) S/N |
|---------------|----------|-----------|----------|----------|------------|--------------------|------------------|--------------------------|------------------|----------------|---------------------|------------------|
| 50 | 27 | 46 | 2e | 24 | 2 | 7 | 11 | 4 | 25 | 4 | 5247206 | 4234126 |
| 51 | 25 | 39 | 28 | 29 | GF-4 | 3 | 24 | 15 | 22 | 13 | 1247043 | 5229066 |
| 52 | 17 | 31 | 38 | 32 | GF-11 | 10 | 15 | 9 | 23 | 9 | 4234143 | 4265160 |
| 53 | 21 | 27 | 36 | 31 | 001 | 4 | 50 | 6 | 17 | 6 | 4228169 | 5261044 |
| 54 | 33 | 37 | 40 | 004 | 1137 | 11 | 3 | 7 | 18 | 14 | 1247043 | 5237071 |
| 55 | 51 | 17 | 32 | 13 | GF-2 | 1 | 31 | 5 | 27 | 5 | 5260031 | 4237205 |
| 56 | 11 | 32 | 42 | 20 | 1502 | 14 | 33 | 14 | 14 | 8 | 4261148 | 4261193 |
| 57 | 53 | 20 | 24 | 27 | 1328 | 5 | 1 | 10 | 19 | 10 | 5265056 | 4229213 |
| 58 | 59 | 34 | 34 | 009 | GF-8 | 31 | 9 | 13 | 21 | 16 | 5246168 | 1247050 |
| 59 | 15 | 28 | 3c | 11 | GF-7 | 8 | 25 | 3 | 15 | 3 | 5234068 | 5242005 |
| 60 | 13 | 30 | 26 | 7 | GF-13 | 9 | 21 | 2 | 4 | 2 | 5234073 | 4236193 |
| 61 | 23 | 18 | 2a | 14 | G-10 | 6 | 17 | 1 | 20 | 1 | 5247168 | 5235065 |
| 62 | 19 | 41 | 2c | 16 | 1327 | 12 | 23 | 16 | 6 | 7 | 1239076 | 4260126 |
| 63 | 31 | 51 | 3e | 33 | GF-15 | 15 | 29 | 12 | 24 | 12 | 5261046 | 4238087 |
| 64 | 55 | 29 | 30 | 15 | 1503 | 13 | 5 | 11 | 26 | 11 | 5235051 | 4234161 |

Seascan and Bigtime Clock Readings for Juan De Fuca Test Deployment

The conventions to calculate the change in time during the deployment, adopted during the 504B cruise, are maintained here. To review the conventions:

First: Always set the SAIL Clock to zero offset relative to the GPS clock after verifying the GPS clock is acquiring at least four satellites and is locked on.

Second: Form Bigtime delta in miliseconds by subtracting Bigtime from SAIL clock time.

Third: Form Seascan delta in miliseconds by subtracting Seascan time from SAIL clock time.

Fourth: Change of Seascan is recovery Seascan delta minus Seascan deployment delta.
Change of Bigtime is recovery Bigtime delta minus Bigtime deployment delta

| OBS # | | Deployment | Recovery | Bigtime Change in msec. | Seascan Change in msec. |
|-------|------------|----------------------|---------------------|-------------------------|-------------------------|
| | SAIL | 0156 19:54:21.054558 | 0158 3:59:07.053578 | | |
| | @ Bigt | 802382061 | 802497547 | | |
| | Delta | +54.558 | +53.578 | -0.980 | |
| 58 | SAIL @ | 0156 19:55:38.069188 | 0158 3:59:36.068205 | | |
| | Seascan 34 | 0156 19 55 38 | 0158 03 59 36 | | |
| | Delta | +69.188 | +68.205 | | -0.983 |
| | SAIL | 0156 19:04:40.076576 | 0158 1:39:18.076066 | | |
| | @ Bigt | 802379080 | 802489158 | | |
| 62 | Delta | +76.576 | +76.066 | -0.510 | |
| | SAIL @ | 0156 19:06:59.095096 | 0158 1:39:51.094585 | | |
| | Seascan 41 | 0156 19 06 59 | 0158 01 39 51 | | |
| | Delta | +95.096 | +94.585 | | -0.511 |

Seascan and Bigtime Clock Settings for Juan De Fuca

These are the initial clock settings of each instrument during the Juan de Fuca deployment. These settings along with the readings upon recovery will quantify the clock drifts and be usable for end point corrections.

| OBS# | | Deployment | Recovery | Bigtime delta | Seascan delta |
|------|------------|-----------------------|----------|---------------|---------------|
| | SAIL | 0159 21:04:44.985107 | | | |
| | @ Bigt | 802645485 | | | |
| 50 | Delta | -14.893 | | | |
| | SAIL @ | 0159 21:05:33.999495 | | | |
| | Seascan 46 | 0159 21 05 34 | | | |
| | Delta | -0.505 | | | |
| | SAIL | 0159 17:09:54.984914 | | | |
| | @ Bigt | 802631395 | | | |
| 51 | Delta | -15.086 | | | |
| | SAIL @ | 0159 17:10:53.999545 | | | |
| | Seascan 39 | 0159 17 10 54 | | | |
| | Delta | -0.455 | | | |
| | SAIL | 0158 21:55:41.985157 | | | |
| | @ Bigt | 802562142 | | | |
| 52 | Delta | -14.843 | | | |
| | SAIL @ | 0158 21:56:55.999820 | | | |
| | Seascan 31 | 0158 21 56 56 | | | |
| | Delta | -0.180 | | | |
| | SAIL | 0159 20:25:59.986349 | | | |
| | @ Bigt | 802643160 | | | |
| 53 | Delta | -13.651 | | | |
| | SAIL @ | 0159 20:27:06.001009 | | | |
| | Seascan 27 | 0159 20 27 06 | | | |
| | Delta | +1.009 | | | |
| | SAIL | 159 20: 001:03.984371 | | | |
| | @ Bigt | 802641664 | | | |
| 54 | Delta | -15.629 | | | |
| | SAIL @ | 0159 20:02:03.998998 | | | |
| | Seascan 37 | 0159 20 02 04 | | | |
| | Delta | -1.002 | | | |
| | SAIL | 0159 01:28:16.985182 | | | |
| | @ Bigt | 802574897 | | | |
| 55 | Delta | -14.818 | | | |
| | SAIL @ | 0159 01:29:12.999815 | | | |
| | Seascan 17 | 0159 01 29 13 | | | |
| | Delta | -0.185 | | | |
| | SAIL | 0158 22:23:58.985533 | | | |
| | @ Bigt | 802563839 | | | |
| 56 | Delta | -14.467 | | | |
| | SAIL @ | 0158 22:25:02.999887 | | | |
| | Seascan 32 | 0158 22 25 03 | | | |
| | Delta | -0.113 | | | |

| | | | | | |
|----|------------|----------------------|--|--|--|
| | SAIL | 0159 20:46:17.983574 | | | |
| | @ Bigt | 802644378 | | | |
| 57 | Delta | -16.426 | | | |
| | SAIL @ | 0159 20:47:08.998214 | | | |
| | Seascan 20 | 0159 20 47 09 | | | |
| | Delta | -1.786 | | | |
| | SAIL | 0158 18:49:57.981408 | | | |
| | @ Bigt | 802550997 | | | |
| | Delta | -18.592 | | | |
| 58 | SAIL @ | 0158 18:51:25.999940 | | | |
| | Seascan 34 | 0158 18 51 26 | | | |
| | Delta | -0.060 | | | |
| | SAIL | 0159 19:27:36.980740 | | | |
| | @ Bigt | 802639657 | | | |
| 59 | Delta | -19.260 | | | |
| | SAIL @ | 0159 19:28:30.999285 | | | |
| | Seascan 28 | 0159 19 28 31 | | | |
| | Delta | -0.715 | | | |
| | SAIL | 0159 18:40:28.984893 | | | |
| | @ Bigt | 802636829 | | | |
| 60 | Delta | -15.107 | | | |
| | SAIL @ | 0159 18:41:28.999520 | | | |
| | Seascan 30 | 0159 18 41 29 | | | |
| | Delta | -0.480 | | | |
| | SAIL | 0158 20:19:47.980877 | | | |
| | @ Bigt | 802556388 | | | |
| 61 | Delta | -19.123 | | | |
| | SAIL @ | 0158 20:20:50.999402 | | | |
| | Seascan 18 | 0158 20 20 51 | | | |
| | Delta | -0.598 | | | |
| | SAIL | 0158 21:23:26.981474 | | | |
| | @ Bigt | 802560207 | | | |
| 62 | Delta | -18.526 | | | |
| | SAIL @ | 0158 21:24:56.999994 | | | |
| | Seascan 41 | 0158 21 24 57 | | | |
| | Delta | -0.006 | | | |
| | SAIL | 0159 18:04:02.984485 | | | |
| | @ Bigt | 802634643 | | | |
| 63 | Delta | -15.515 | | | |
| | SAIL @ | 0159 18:04:59.999113 | | | |
| | Seascan 51 | 0159 18 05 00 | | | |
| | Delta | -0.887 | | | |
| | SAIL | 0158 23:02:43.981360 | | | |
| | @ Bigt | 802566164 | | | |
| 64 | Delta | -18.640 | | | |
| | SAIL @ | 0158 23:03:43.999893 | | | |
| | Seascan 29 | 0158 23 03 44 | | | |
| | Delta | -0.107 | | | |

Opportunities for Improvement

Prior to the test deployment on June 5 OBS 58 was assembled on deck operating under battery power. The assumptions were that, after the recorder reset button had been engaged, the disk power would be shut off. The following morning the battery voltages were measured again and the disk battery read two volts lower than it did when read on the 5th. This is a normal indication that the disk was powered up. Since there was no command to power the disk, the disk must have been powered all night (~12 hours). The disk batteries have 25 ampere-hours of capacity and 12 had been used overnight. It would take less than 6 ampere hours to fill both disks in OBS 58 but it was decided not to tempt Murphy. The disk section of the battery pack was replaced with an unused spare. A note was made to check the recorder reset switch on the 100 Ft cable and to clean the pins on its connector.

During the recovery debriefing from the test deployment of OBS 58 the recorder could not be aroused with the reset switch. The 100 ft cable was unseated from the recorder and reseated twice but did not catch the recorder's attention. Battery power was maintained on the recorder and the recorder was moved to the lab. The gray cable was used to debrief the recorder in the normal manner and the recorder responded with no problems. The 100 foot cable was examined and it was determined that the pins on the connector end were faulty. The connector end of the 100 foot cable was replaced by the connector end of the gray cable. No further problems with the 100 foot cable were encountered during the deployment of the 15 OBS instruments. A new connector pig tail must be ordered along with some spares for the gray cable.

The data from the test deployment of OBS 62 was missing the approximately 3.5 megabytes of final data. This is about 55 minutes of data. The recorder dumps at 3,670,016 bytes of data which is about 58 minutes of data. Clearly the recorder did not reach its dump number and it did not respond to a dump command from the acquisition. Upon debriefing the Juan De Fuca instruments we will dump any data in recorder memory to disk if the disk is not full. The option to dump to a file on the PC using procomm exists. This would take $(3700000 \text{ bytes} * 2(\text{for ASCII})) / 960 \text{ bytes / sec} = 7708 \text{ seconds} = 2.14 \text{ hours per instrument}$.

At first glance the lockout on the event schedule of the test deployment did not seem to work. The lockout maximum was set for 100 events per six hour period but within the first six hours of the first event schedule there were approximately 130 events. The reason is that the lockout period is not synchronized to the event period. The lockout counter began counting as soon as the clock was started. Therefore there were actually two lockout periods overlapping the first event schedule.

The on/off switch of one of the one year battery cases was rotating freely and could not turn on the battery. The switch was replaced. When the pressure housing was opened the cover was forced off by internal pressure. The batteries had been sealed in the pressure housing for one year and the assumption is made that there had been some out gassing from the alkaline cells.

The one year recorder had to be modified by wiring the external power connector. During this process the +18 Volts and ground wires were reversed and the fuses in both battery cases were blown. When the second battery case was opened to replace the fuse it too was found to be under pressure.

When first assembled on deck the recorder for the test deployment of OBS 58 would not respond to the SAIL loop. The recorder was opened and it was found that the SAIL connector on the SAIL board was off, probably due to improper handling. The connector was reseated and the OBS was deployed. We should investigate the possibility of replacing all the connectors in the recorder with Molex C- grid connectors with their positive locking mechanism. Additionally we should look at the routing of the wires to see if there is some way of reducing their exposure during handling.

During deck operations the cable attaching the geophone sensor package with the acquisition package takes a beating. One cable had to be replaced prior to the main deployment. We should order some additional cables to replace the more seriously compromised cables presently deployed.

There is some concern that the gimbals of the spare geophone were assembled incorrectly. The geophone needs to be disassembled and examined. If it is assembled incorrectly it must be put right and we must understand why it was assembled incorrectly. All leveling and centering tests must be done on the geophone.

The minus 8 volts on one of the Tauber Electronic battery packs had two cells that were open. The cells are internally fused and the fuses of these two cells had been blown. We will review our handling process to try to understand where they were blown and to take steps to prevent blowing cell fuses in the future.

Appendix 8: OBS Data Acquisition Program Parameters

Rationale for the Choice of Acquisition Program Parameters.

The objective of the 8 OBSs deployed well to the west of the rise axis is to record tectonic events and to monitor T-phase seismicity for subsequent comparisons with earthquake locations obtained from the US Navy SOSUS array. To record T-phases at ranges of up to 100-150 km (the distance to the Sovanco transform fault) requires a record length of 120 s. To maximize the total event capacity of these instruments, we decided that only 4 off-axis OBS would be programmed to acquire 120 s records at any given time and that the remainder should record 40 s records (40 s is more than sufficient to record crustal body waves from local events). The test deployments showed that small tectonic events trigger best using the vertical seismometer and we chose a relatively small short-term to long-term threshold of 3 (a value of 7 was judged optimal during the FARA experiments on the Mid-Atlantic Ridge) because many of the tectonic events may be fairly small. Given the large recording capacity of the OBSs we are willing to accept a larger number of spurious triggers as the price for recording all useful tectonic events.

The objective of the 7 OBSs deployed near the rise axis is to record tectonic events and to monitor seismicity associated with the vent field. The test deployments showed that swarm activity is capable of triggering the OBS almost continuously so there is no need to lengthen individual records to monitor long swarm sequences. A 40 s record was chosen for these instruments. The test deployments showed that a trigger ratio of 7 on the vertical seismometer is sufficiently small to record swarm earthquakes although small tectonic events observed on the off-axis OBS failed to trigger the on-axis instrument. Since these tectonic events are important we decided to reduce the trigger ratio to 3.

During periods of event detect recording, the maximum number of events in any give 6 hour period was capped to insure that the instruments do not fill their disk capacity before the end of the event detect portion of the experiment. All OBSs were programmed to recorded continuously for 1.5 days during the shooting and for about 14 days at the end of the experiment. This final period of continuous recording hedges against the possibility of recording only a small number of triggers during the event detect portions of the deployment.

• Test Deployment

A number of separate programs were used to program the instruments depending upon their location relative to the ridge axis, time of deployment, and planned time of recovery.

• OBS #62 'Off-Axis' •

| Mode | Start/End Times | Rec. Len | History | Lock Out | Trig Ch. | Thresh |
|--------------|------------------------------------|----------|---------|-------------|----------|--------|
| Event Detect | 2300UT 5th June 0600UT 6th June | 120s | 20s | 100 /6hr | 1 | 3 |
| Continuous | 0605UT 6th June 0800UT 6th June | | | | | |
| Event Detect | 0805UT 6th June 1500UT 6th June | 120s | 20s | 100 /6hr | 4 | 3 |
| Event Detect | 1505UT 6th June 2200UT 6th June | 40s | 10s | 100 /6hr | 1 | 3 |
| Continuous | 2205UT 6th June 2400UT 6th June | | | | | |

• OBS #58 'On-Axis' •

| Mode | Start/End Times | Rec. Len | History | Lock Out | Trig Ch. | Thresh |
|--------------|------------------------------------|----------|---------|-------------|----------|--------|
| Event Detect | 0000UT 6th June 0700UT 6th June | 80s | 10s | 100 /6hr | 1 | 7 |
| Continuous | 0705UT 6th June 0900UT 6th June | | | | | |
| Event Detect | 0905UT 6th June 1600UT 6th June | 80s | 10s | 100 /6hr | 4 | 3 |
| Event Detect | 1605UT 6th June 2300UT 6th June | 80s | 10s | 100 /6hr | 1 | 7 |
| Continuous | 2305UT 6th June 0100UT 7th June | | | | | |

• **Main Experiment**

A number of separate programs were used to program the instruments depending upon their location relative to the ridge axis, time of deployment, and planned time of recovery.

• **OBS #62,58,61 'Off-Axis 1' •**

| Mode | Start/End Times | Rec. Len | History | Lock Out | Trig Ch. | Thresh |
|--------------|---------------------------------------|----------|---------|-------------|----------|--------|
| Event Detect | 0600UT 8th June 0100UT 10th June | 120s | 20s | 100 /6hr | 1 | 3 |
| Continuous | 0105UT 10th June 1300UT 11th June | | | | | |
| Event Detect | 1305UT 11th June 0100UT 30th June | 120s | 20s | 100 /6hr | 1 | 3 |
| Event Detect | 0105UT 30th June 0100UT 20th July | 40s | 10s | 100 /6hr | 1 | 3 |
| Continuous | 0105UT 20th July 1455UT 2nd August | | | | | |
| Calibration | 1500UT 2nd August | | | | | |

• **OBS #51 'Off Axis 1' •**

| Mode | Start/End Times | Rec. Len | History | Lock Out | Trig Ch. | Thresh |
|--------------|---------------------------------------|----------|---------|-------------|----------|--------|
| Event Detect | 0300UT 9th June 0100UT 10th June | 120s | 20s | 100 /6hr | 1 | 3 |
| Continuous | 0105UT 10th June 1300UT 11th June | | | | | |
| Event Detect | 1305UT 11th June 0100UT 30th June | 120s | 20s | 100 /6hr | 1 | 3 |
| Event Detect | 0105UT 30th June 0100UT 20th July | 40s | 10s | 100 /6hr | 1 | 3 |
| Continuous | 0105UT 20th July 1455UT 2nd August | | | | | |
| Calibration | 1500UT 2nd August | | | | | |

• OBS #52, #56, #64, #55 'On Axis' •

| Mode | Start/End Times | Rec. Len | History | Lock Out | Trig Ch. | Thresh |
|--------------|---------------------------------------|----------|---------|-------------|----------|--------|
| Event Detect | 1200UT 8th June 0100UT 10th June | 40s | 10s | 200 /6hr | 1 | 3 |
| Continuous | 0105UT 10th June 1300UT 11th June | | | | | |
| Event Detect | 1305UT 11th June 0100UT 30th June | 40s | 10s | 200 /6hr | 1 | 3 |
| Event Detect | 0105UT 30th June 0100UT 20th July | 40s | 10s | 200 /6hr | 1 | 3 |
| Continuous | 0105UT 20th July 1455UT 3rd August | | | | | |
| Calibration | 1500UT 3rd August | | | | | |

• OBS #53, #57, #50 'On Axis' •

| Mode | Start/End Times | Rec. Len | History | Lock Out | Trig Ch. | Thresh |
|--------------|---------------------------------------|----------|---------|-------------|----------|--------|
| Event Detect | 1400UT 9th June 0100UT 10th June | 40s | 10s | 200 /6hr | 1 | 3 |
| Continuous | 0105UT 10th June 1300UT 11th June | | | | | |
| Event Detect | 1305UT 11th June 0100UT 30th June | 40s | 10s | 200 /6hr | 1 | 3 |
| Event Detect | 0105UT 30th June 0100UT 20th July | 40s | 10s | 200 /6hr | 1 | 3 |
| Continuous | 0105UT 20th July 1455UT 3rd August | | | | | |
| Calibration | 1500UT 3rd August | | | | | |

• OBS #63, #60, #59, #54 'Off Axis 2' •

| Mode | Start/End Times | Rec. Len | History | Lock Out | Trig Ch. | Thresh |
|--------------|---------------------------------------|----------|---------|-------------|----------|--------|
| Event Detect | 0300UT 9th June 0100UT 10th June | 40s | 10s | 100 /6hr | 1 | 3 |
| Continuous | 0105UT 10th June 1300UT 11th June | | | | | |
| Event Detect | 1305UT 11th June 0100UT 30th June | 40s | 10s | 100 /6hr | 1 | 3 |
| Event Detect | 0105UT 30th June 0100UT 20th July | 120s | 20s | 100 /6hr | 1 | 3 |
| Continuous | 0105UT 20th July 1455UT 2nd August | | | | | |
| Calibration | 1500UT 2nd August | | | | | |

Appendix 9: New or Modified Check Lists for OBS

OBS Post Shipping Test .

Acquisition S/N _____ Recorder S/N _____
Sensor S/N _____, Hyd Pre Amp S/N _____, Hyd S/N _____
Date _____, Time _____.

Short agc NI to AGND. Take 20 sec. data. File Name _____.

Connect sig gen to NI. 5 Hz 4VPP Take 20 sec. of data File Name _____.

Program for event detect. 10 sec pre cursor, 20 sec's of data Start instrument
watch 'P' create event at 12 seconds into schedule. File Name _____.

Check Seascan clock, log in clock book. _____.

Connect shorted sensor and take 20 sec's of data @ step 8 File Name _____.

Unshort sensor _____.

Connect all sensors, take 20n sec's of data. Are they alive? File Name _____.

Send 20 seconds of phony data to disk 1. Did it arrive ok? _____.

Send 20 seconds of phony data to disk 2. Did it arrive ok? _____.

Check and install instrument battery... refer to Rec prep chklst

Check and install Seascan battery... refer to Aq prep chklst

Comments:

OBS Log (page 1 of 2)

CRUISE _____ EXPERIMENT _____ OBS # _____

DEPLOYMENT DATE/TIME _____ GMT
(RELEASE FROM SHIP)

DEPLOYMENT POSITION @ _____ GMT LATITUDE _____
LONGITUDE _____

HOW DETERMINED _____

RECEIVER DEPTH _____ M/FT/FM @ _____ GMT

WATER DEPTH _____ M/FT/FM @ _____ GMT

HOW DETERMINED _____

RECOVERY DATE/TIME _____ GMT
(ALONGSIDE SHIP)

RECOVERY POSITION @ _____ GMT LATITUDE _____
LONGITUDE _____

HOW DETERMINED _____

RECOVERY DATE/TIME _____ GMT
(ON BOARD SHIP)

RECOVERY POSITION @ _____ GMT LATITUDE _____
LONGITUDE _____

HOW DETERMINED _____

OBS LOG (page 2 of 2)

Cruise _____ Experiment _____ OBS # _____

Mechanical / Recovery Aids:

checks

Balls _____
Anchor _____
EG&G Releases _____
Air Acoustics _____
9 KHz S/N _____ Reply _____ KHz
11 KHz S/N _____ Reply _____ KHz
Flag _____
Radio S/N _____ Freq. _____ MHz
Flashers S/N _____
Sugar releases installed left and right side of deployment arm _____
Sugar releases installed on geophone package _____
Tilt indicator installed on sensor orb _____
Scripps Compass Installed on Frame _____

Electronics:

Acquisition S/N _____
Seascan Clock S/N _____
Recorder S/N _____
Sensor Orb S/N _____
Hydrophone S/N _____
Preamp S/N _____
Polyethylene pressure case mounts tightened _____
Cable tie wrap in place _____

Cabling:

EG&G Release to ACQ S/N _____
Hydrophone to Preamp S/N _____
Preamp to ACQ S/N _____
Sensor Orb to ACQ S/N _____
Serial Link S/N _____

Shore Power Dummy on REC _____
Second Dummy on REC _____
Cables tied up _____
Sensor cable and chain taped up _____

OBS Recorder Preparation Checklist

Cruise _____ Experiment _____ OBS # _____

| Recorder | S/N _____ | checks |
|---------------------------|------------------------------|-----------------------|
| Disk #1 (bottom) | S/N _____ | Locked with key _____ |
| Disk #2 (top) | S/N _____ | Locked with key _____ |
| Disk assembly screw | in place | _____ |
| Foam disk retainers | in place | _____ |
| Battery check | +24 _____ +12 _____ -8 _____ | _____ |
| Check and clean | O-rings | _____ |
| Board check and inventory | | _____ |
| Check / Replace | zincs | _____ |
| Assemble | | _____ |
| Purge | _____ times _____ lbs | _____ |
| Pull final vacuum | _____ in. Hg | _____ |

OBS Sensor Orb Preparation Checklist

Cruise _____ Experiment _____ OBS # _____

Sensor Orb S/N _____ checks _____

Unshort with grey box _____

Seismometers connected to instrument. _____

Visual check _____

Acquisition Configuration

Date _____ Cruise _____ Deployment _____.

Acquisition Serial Number _____.

| | | | |
|-----------------|------------|-----------------|------------|
| Seascan Clock | S/N _____. | C44 A/D | S/N _____. |
| Power Regulator | S/N _____. | Analog A/D | S/N _____. |
| RAM-2M | S/N _____. | Analog AGC 1 | S/N _____. |
| CPU8088 | S/N _____. | Analog AGC 2 | S/N _____. |
| Serial Link | S/N _____. | Analog AGC 3 | S/N _____. |
| PAR-40 | S/N _____. | Analog AGC 4 | S/N _____. |
| QDART | S/N _____. | Analog AGC 5 | S/N _____. |
| SAIL-EE | S/N _____. | Analog AGC 6 | S/N _____. |
| STB | S/N _____. | 4 Pole Filter | S/N _____. |
| Digital AGC 1 | S/N _____. | 8 Pole Filter | S/N _____. |
| Digital AGC 2 | S/N _____. | DPG Preamp | S/N _____. |
| | | HFD(water wave) | S/N _____. |

4 Pole Filter Installed Not Installed

Corner frequency _____.

8 Pole Filter Installed Not Installed

Corner frequency _____.

Ram-2M PROM Version Number _____.

A/D Jumper Configuration

| | | | | | | | | | | | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

-8 Volt Regulator Jumper: Regulator Installed Regulator Bypassed

Recorder Configuration

Date _____ Cruise _____ Deployment _____

Recorder Serial Number _____

Power Regulator S/N _____

Mem-64 S/N _____

PROM Version Number V/N _____

CPU8088 S/N _____

SAIL/Serial Link S/N _____

A to D S/N _____

C44 to SCSI Interface S/N _____

Ramble #1 S/N _____

Ramble #2 S/N _____

Disk #1 (Bottom) S/N _____

Disk #2 (Top) S/N _____

Utility S/N _____

Disk Selection S/N _____

Predeployment Record (page 1 of 2)
(Using Grey Box and 100' Cable for 1 Year Instrument)

Date _____
 OBS Frame No. _____

Acquisition pkg S/N _____
 Recorder pkg S/N _____
 Clock S/N _____

SETUP SEQUENCE

- Grey Box switch off _____
- Battery case switches off _____
- Recorder pressure case switch on _____
- Unshort SAIL _____
- Address recorder & measure voltages _____
- Recorder pressure case battery switch off _____
- Battery case A switch on _____
- Unshort SAIL _____
- Address recorder & measure voltages _____
- Short SAIL _____
- Battery case A switch off _____
- Battery case B switch on _____
- Unshort SAIL _____
- Address recorder & measure voltages _____
- Battery case A switch on _____
- Recorder pressure case switch on _____

PRELIMINARY CHECKS

- Start PROCOMM, open log file _____
- Press acquisition and recorder reset switches _____
- Address acquisition _____
 - Version, status _____
 - Timer menu (t, Z, n=5, exit) _____
- Address recorder _____
 - Version, status _____
 - Disk init OK _____
- Pressure case battery switch on _____
- "G" _____
- Start LBA Disk 2 _____
- Start LBA Disk 1 _____
- "g" _____
- Address acquisition _____
- Qdarts enable _____
- External menu _____
- Set gains 1,2 and 3 to 0 _____
- Main menu _____
- Qdarts off _____
- S menu _____
- Collect 30 seconds of data _____
- Reset recorder _____
- Check error codes of recorder _____
- End LBA for disk 1 _____
- Read data off disk to file _____
- Power down the disk _____
- Close log file _____
- Exit Procomm _____
- Plot Data file and print plot _____

Predeployment Record (page 2 of 2)
(Using Grey Box and 100' cable for 1 Year Instrument)

Programming

Start Procomm _____

Open log file _____

Reset both packages _____

Address acquisition _____

Timer menu (t,Z,n=no.of channels, exit) _____

Address recorder _____

 Voltages _____

 'G' _____

 Beginning LBA Disk 1 _____

 Beginning LBA Disk 2 _____

 "g" _____

Address acquisition _____

 Enable QDARTS _____

 Go to External menu "E" _____

 Set gains ch1 _____ ch2 _____ ch3 _____

 Exit to main menu, Disable Qdarts _____

 Event menu "V" _____

 Set thresholds "t" _____

 ch1 _____ ch2 _____ ch3 _____ ch4 _____

 Set period "p" _____

 Set Max ? _____

 Set Lockout "?" _____

 Status "s" _____

 Schedule menu, load schedule files _____

 _____ .sk1

 _____ .sk2

 _____ .sk3

Status _____

Clock menu, start BIGTIME at _____

Main menu _____

Open loop to SAILCLOCK _____

 (switch 2 on blue box)

Grab two BIGTIMES ('g'), then '#' _____

Seconds Bigtime is _____

Alt F4 convert bigtime using bigt _____

Change baud rate, alt P, 5 _____

Short/unshort loop to wake Seascan _____

 (switch 1 on blue box)

Address Seascan clock (#CK(No.)) _____

Read Seascan clock twice (?T) _____

Second Seascan time is _____

SAILCLOCK #CL?L, !L, R, L, !S _____

 for Bigtime _____

 for Seascan _____

Unaddress SAIL Clock (#) _____

Short loop to SAILCLOCK _____

 (switch 2 on blue box)

Change baud rate, alt P, 11 _____

Check schedules, 'p' operation, then 'V' _____

'e', then 's' _____

Close, check log file _____

Unaddress '#' _____

Close, check log file _____

Short Sail loop, remove 100 foot Cable, record time _____

Predeployment Record (page 2 of 2)

(Using Grey Box and 100' cable)

Programming

Start Procomm _____
Open log file _____
Reset both packages _____
Address acquisition _____
Timer menu (t,Z,n=no.of channels, exit) _____
Address recorder _____
 'G' _____
 Beginning LBA Disk 2 _____
 Beginning LBA Disk 1 _____
 "g" _____
Address acquisition _____
 Enable QDARTS _____
 Go to External menu "E" _____
 Set gains ch1_____ ch2_____ ch3_____ _____
 Exit to main menu, Disable Qdarts _____
 Event menu "V" _____
 Set thresholds "t" _____
 ch1_____ ch2_____ ch3_____ ch4_____ _____
 Set period "p" _____
 Set Max "m" _____
 Status "s" _____
 Schedule menu, load schedule files _____
 _____ .sk1 _____
 _____ .sk2 _____
 _____ .sk3 _____
Status _____
Clock menu, start BIGTIME at _____
Main menu _____
Open loop to SAILCLOCK _____
 (switch 2 on blue box) _____
Grab two BIGTIMES ('g'), then '#' _____
Seconds Bigtime is _____
Alt F4 convert bigtime using bigt _____
Change baud rate, alt P, 5 _____
Short/unshort loop to wake Seascan _____
 (switch 1 on blue box) _____
Address Seascan clock (#CK(No.)) _____
Read Seascan clock twice (?T) _____
Second Seascan time is _____
SAILCLOCK #CL?L, !L, R, L, !S _____
 for Bigtime _____
 for Seascan _____
Unaddress SAIL Clock (#) _____
Short loop to SAILCLOCK _____
 (switch 2 on blue box) _____
Change baud rate, alt P, 11 _____
Check schedules, 'p' operation, then 'v' _____
'e', then 's' _____
Close, check log file _____
Unaddress '#' _____
Short Sail loop, remove 100 foot Cable, record time _____

Predeployment Record (page 1 of 2)

(Using Grey Box and 100' Cable)

Date _____

Acquisition pkg S/N _____

OBS Frame No. _____

Recorder pkg S/N _____

Clock S/N _____

SETUP SEQUENCE

Grey Box switch off _____
Pressure case battery switch off _____
Short SAIL _____
Pressure case battery switch on _____
Unshort SAIL _____

PRELIMINARY CHECKS

Start PROCOMM, open log file _____
Press acquisition and recorder reset switches _____
Address acquisition _____
 Version, status _____
 Timer menu (t, Z, n=4, exit) _____
Address recorder _____
 Version _____
"G" _____
Start LBA Disk 2 _____
Start LBA Disk 1 _____
 "g" _____
Address acquisition _____
Qdarts enable _____
External menu _____
Set gains 1,2 and 3 to 0 _____
Main menu _____
Qdarts off _____
S menu _____
Collect 20 seconds of data _____
Recorder still in sleep mode _____
Reset recorder _____
Check Voltages _____
Check error codes of recorder _____
End LBA for disk 1 _____
Read data off disk to file _____
Power down the disk _____
Close log file _____
Exit Procomm _____
Plot Data file and print plot _____

OBS HARDWARE RECOVERY LOG

Cruise _____ Experiment _____ OBS# _____

Mechanical / Recovery Aids:

checks

Balls _____

EG&G Releases (released and disabled?)

9 kHz S/N _____

11 kHz S/N _____

Flag (upright?) _____

Radio S/N _____

Flashers S/N _____

S/N _____

Tilt indicator checked _____

Compass direction checked _____

Corrosion _____

Cabling:

Connector status (pins checked in lab) _____

Comments:

General

This document describes the system for logging the shot instant and bullet velocity of the explosive shots on the Juan de los Rios mine. It uses a specialized version of the Robotron Shot Instant Logging hardware in conjunction with the SAIL (Shot and Instant Logging) software and the OBS clock circuit. The new hardware is called a Timing Trigger Generator.

The output from the Timing Trigger Generator are used as a SAIL input. The SAIL hardware generates characters which cause the SAIL clock to latch data. These data are then read and logged manually by an operator using the SAIL software. In the future, a program will be written to automate the logging of the times and their conversion to the desired time: public time, shot time, etc.

Appendix 10: Shot Instant recording System

Equipment

The equipment necessary for this operation is:

- Timing Trigger Generator
- blast phone
- selector's switch
- OBS timing rack
- Robotron oscilloscope
- SAIL clock
- OBS receiver
- battery backup
- PC interfaced to the clock and OBS SAIL modules
- PROCOMM on the PC

Installation

Connect the various items as shown in the attached schematic. Use either "Shot Instant Output" (no. 1 and no. 2 are identical). There is no power switch on the Timing Trigger Generator, it is always powered when the power pack is connected.

On the Timing Trigger Generator, set the rear panel switch for "explosives", the front panel gain control to "+30 dB", the "hydraulic gate" pot to mid range, the "latching time" to 1 minute. When the OBS SAIL equipment is operating and that the logic on the SAIL clock is active. Ensure that the feedback on the SAIL hardware is set to create the phase pulse output.

System Test

When the system is connected as described above, use PROCOMM and address the SAIL clock (PCI 2) from the computer keyboard.

22 May 93

Shot Instant Logging Juan de Fuca Cruise

General

This document describes the system for logging the shot instant and bubble pulse of the explosive shots on the Juan de Fuca cruise. It uses a simplified version of the Koelsch Shot Instant Logging hardware in conjunction with the SAIL clock and Rubidium oscillator used for OBS clock checking. The new hardware is called a Timing Trigger Generator.

The triggers from the Timing Trigger Generator are wired to a SAIL interface box to generate @ characters which cause the SAIL clock to latch time. These times are read and logged manually by an operator using PROCOMM. In the future, a program will be written to automate the logging of the times and their conversion to the desired times: bubble pulse, burn time, etc.

Equipment

The equipment necessary for this operation is:

- Timing Trigger Generator
- blast phone
- shooter's switch
- OBS timing rack
 - Rubidium oscillator
 - SAIL clock
 - GPS receiver
 - battery backup
- PC interfaced to the clock and OBS SAIL manifold
- PROCOMM on the PC.

Installation

Connect the various items as shown in the attached schematic. Use either "Shot Instant Output" (no. 1 and no. 2 are identical). There is no power switch on the Timing Trigger Generator, it is always powered when the power pack is connected.

On the Timing Trigger Generator, set the rear panel switch for "explosives", the front panel gain switch to "+20 dB", the "hydrophone gain" pot to mid range, the "blanking time" to 5.

Ensure that the OBS SAIL equipment is operating and that the loop to the SAIL clock is active. Ensure that the switch on the SAIL interface box is set to enable the phase pulse input.

System Test

When the system is connected as described above, start PROCOMM and address the SAIL clock (#CLK) from the computer keyboard.

Check the clock current stack contents (?L). Next, hit the shooter's switch then strike the hydrophone gently on the bench two times separated by about one second. Address the SAIL clock and read the stack. There should be three new times on the stack which represent the time that the switch was hit and the two strikes on the hydrophone. Note that the stack times as displayed are in reverse time order.

To prepare for operation, adjust the blanking time to a value less than the expected bubble pulse - see the table below. To check the setting, repeatedly strike the hydrophone quickly two times and check the clock stack. Reduce the time between the two strikes until only one time appears on the stack. Calculate the difference between the pairs of times. None should be less than the nominal blanking time. Alternatively, the width of the negative going pulse on the "shot instant phase pulse" (either 1 or 2) can be monitored on an oscilloscope.

Operation

Install, connect, and power the equipment as described above. Start PROCOMM and open a log file. Check that the SAIL clock is operating and tracking GPS time. Stream the blast phone.

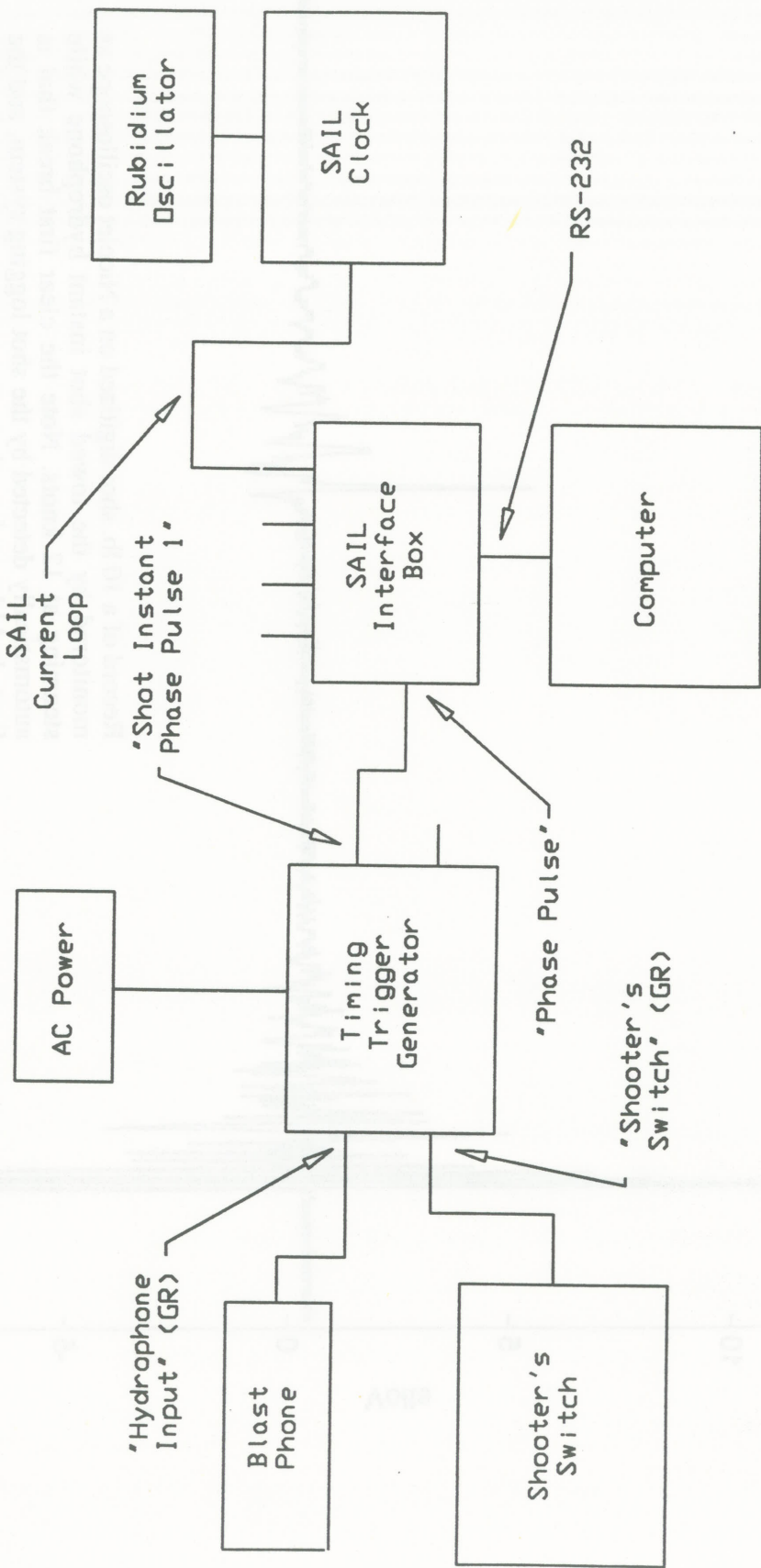
Before each shot, read the SAIL clock stack. After the shot, read the stack again. The last two numbers on the stack (the most recent) are the time of the bubble pulse and the first arrival respectively. The third number on the stack is the over-the-side time for the shot. Even though the PROCOMM log will capture all times read, it is recommended that manual logging be used to avoid later confusion.

From these times, the following can be calculated:

Shot time = first arrival time
Burn time = (first arrival time) - (over-the-side time)
Bubble period = (bubble pulse time) - (first arrival time).

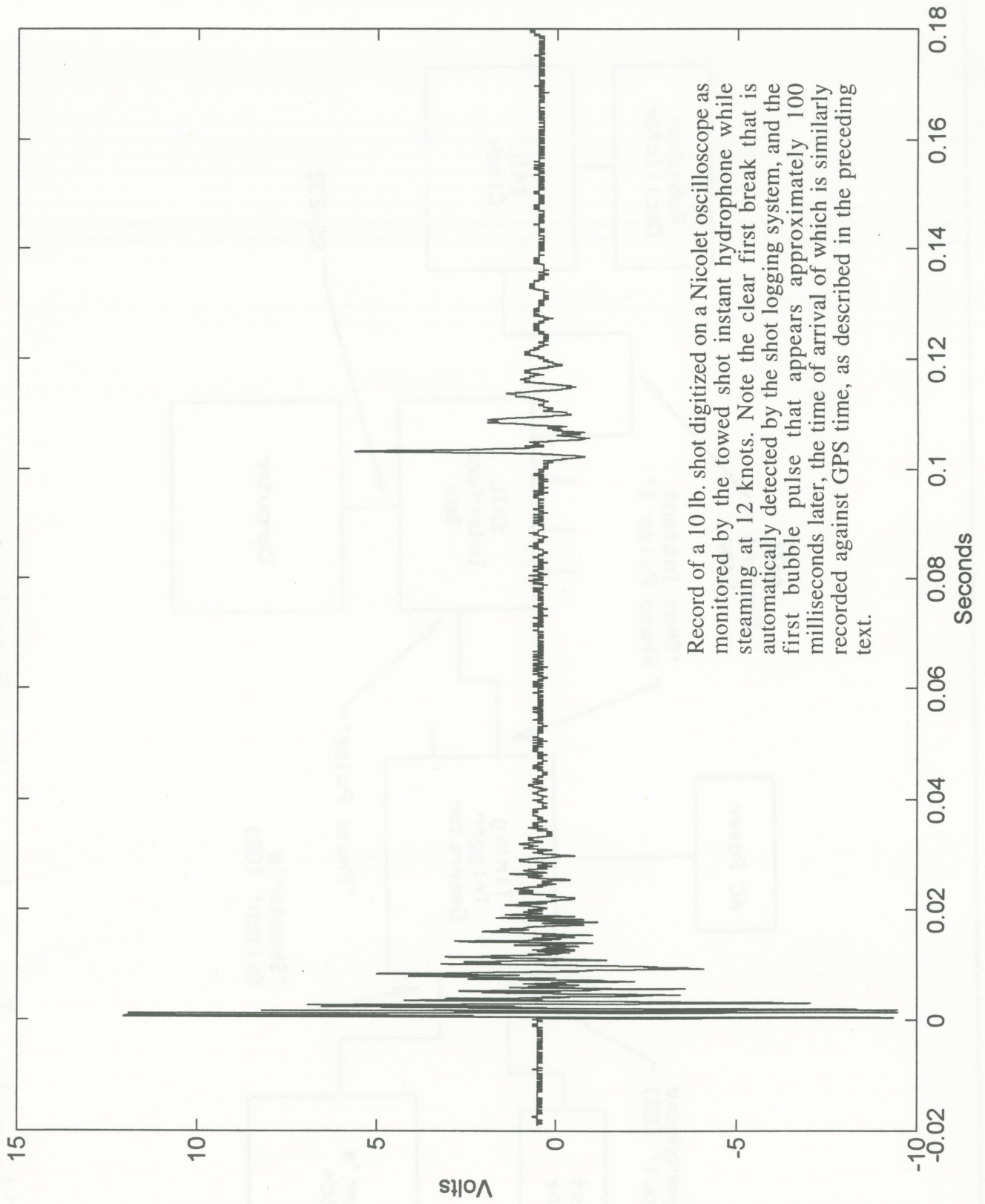
Table of blanking times

| Pot setting | blanking time |
|-------------|---------------|
| 10 | 355 msec |
| 9 | 315 |
| 8 | 285 |
| 7 | 265 |
| 6 | 215 |
| 5 | 175 |
| 4 | 150 |
| 3 | 115 |
| 2 | 80 |
| 1 | 40 |
| 0 | 8 |



Shot Instant Interconnections

Juan De Fuca Shot # 34



Record of a 10 lb. shot digitized on a Nicolet oscilloscope as monitored by the towed shot instant hydrophone while steaming at 12 knots. Note the clear first break that is automatically detected by the shot logging system, and the first bubble pulse that appears approximately 100 milliseconds later, the time of arrival of which is similarly recorded against GPS time, as described in the preceding text.

Appendix 11: Schedule for Meeting Obligations to Canadian Government

The approval of the Government of Canada to operate in their waters requires that we provide a schedule for the provision of the full data results to the Canadian government. This was the first leg of a two leg experiment and the objective was to deploy 15 ocean bottom seismographs to be recovered during the second leg in early August, 1995. The principal data resulting from this experiment will not be recovered until the second leg. This cruise report includes a full description of the small amount of test data recovered during the first leg. The cruise report pertaining to the second leg will provide a complete schedule for reporting the data results arising from the whole experiment.

Appendix 12: Shipboard Data Processing System

Two SUN workstations, indigo and jade, each operating with 28Mb of memory were brought aboard the R/V Wecoma for handling the OBS data from the test deployment. Indigo, a SPARC 1+, had as its peripherals a Unison 3-slot box with two external disk drives and an Exabyte 8mm cartridge tape drive. An ADS 2-slot disk garage for accepting disks out of the OBSs was also attached. One slot housed a scratch data disk that was automounted on jade as well. Jade, a SPARC ELC, also operated with an external Exabyte drive and a 2-slot ADS disk garage that experienced intermittent power supply (?) problems that will have to be fixed before the pickup cruise. Jade's disk garage contained one spare OBS disk mounted as /data. ASCII log files from predeployment and immediate post-recovery checkout of the OBSs on the PC were copied onto indigo through its floppy disk drive mounted as /pcfs. Floppy disks were also used to move records of the shots captured on the Nicolet 490 storage oscilloscope to the SUNs for plotting with MATLAB. Pumori, a networked H-P LaserJet 4M plus printer, was setup to provide laser quality printouts from the SUNs, an APPLE powerbook, and a MAC SE. The two SUNs and the H-P printer were linked together to form their own subnet distinct from the shipboard computing network. For this cruise it was not necessary to expand the network to include the PCs or APPLE computers.

Much of the data processing effort was directed toward providing a quick, but comprehensive look at the data collected during the test deployment. The idea was to:

- 1) make a byte-for-byte copy of the data on 8mm tape,
- 2) create a byte-for-byte copy of the data as a file on hard disk,
- 3) log the disk file and from it create MATLAB format files using the program `obs_ed`,
- 4) review the log files, load the *.mat files into MATLAB and use some plotting script like `reksek` to view the data, and print out the trigger log files, and
- 5) as time permitted make a second copy of the data on tape.

The following commands were used to archive the data to tape and disk and to convert the data to MATLAB format files.

1) to tape:

```
obs_transcribe /dev/rsd5c /dev/rst1 2 45104  
obs62_jdftest_1239076.log
```

2) to disk:

```
obs_transcribe /dev/rsd5c /jdf/obs62_test/obs62.test.raw  
obs62_jdftest_disk.log
```

3) convert data to MATLAB files:

```
obs_ed if=obs62.test.raw ff=mat  
mv obsed.log obs62_jdftest_obsed.log  
mv obs.trigger obs62_jdftest_obsed.trigger  
lprg obs62_jdftest_obsed.trigger
```

...4) 2nd copy to tape:

```
obs_transcribe /dev/rsd5c /dev/rst1 2 45104  
obs62_jdftest_1239076copy2.log
```

Things to think about for the pickup cruise:

- 1) Primary activity is creation of two byte-for-byte tape copies of the data using obs_transcribe.
- 2) Modify obs_transcribe to accept two input disk names.
- 3) Update MATLAB license file on jade. It expires August 1.
- 4) Bring a third ADS disk garage for use as backup to the primary ADS garages and as scratch disk space. Attach to jade and modify the system kernel to accept five disks if necessary.
- 5) Configure a spare disk as a "plug and play" system disk in case one of the two systems doesn't boot up after shipping.
- 6) Don't print out and include in receiver books the obs_transcribe log file, obsed log file, and obsed trigger file. They'll be much too large.
- 7) Look at receiver books at the start of the pickup cruise. Useful information could go into the pickup cruise report as an appendix. If necessary make copies of all the receiver books.

1) Primary activity is creation of two byte-for-byte data using
the...
2) Identify the... to create two byte-for-byte data
3) Identify the... on each...
4) Identify the... for the...
5) Identify the... and... the...
6) Identify the... as a...
7) Identify the...
8) Identify the...
9) Identify the...
10) Identify the...
11) Identify the...
12) Identify the...
13) Identify the...
14) Identify the...
15) Identify the...
16) Identify the...
17) Identify the...
18) Identify the...
19) Identify the...
20) Identify the...