

CRUISE REPORT

RC 26-07

EAST PACIFIC RISE MULTICHANNEL SEISMIC EXPERIMENT

21 May - 21 June 1985

Balboa, Panama - Manzanillo, Mexico

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Cruise Objectives

RC 26-07 was a multichannel seismic investigation of the structure of the East Pacific Rise crest between 9°N and 13°30'N. Working with the Conrad in the two-ship portion of the field program was R/V Thomas Washington of the Scripps Institution of Oceanography (Marathon Leg 15). Our main objective in this experiment was to use single ship CDP and two-ship multichannel seismic techniques to provide better geophysical constraints on the shape and dimensions of the axial magma chamber, its variability along the ridge axis and the nature of Moho in the axial region. We worked on two well-studied segments of the East Pacific Rise, one near 9°N and the other at 13°N. In both areas existing seismic refraction data indicate the presence of an axial low velocity zone, presumably associated with a magma chamber beneath the rise crest. Our objective was to map reflections from the Moho and the roof of the magma chamber in the axial region using a closely spaced grid of 48-channel CDP lines in each area. Two-ship expanding spread profiles and long-range sonobuoys were used with existing refraction data to provide information on the velocity structure of the crust in the axial region.

Cruise Narrative

- 5/21/85 - At 0830L Conrad departed Panama and began a six day transit to the East Pacific Rise (EPR) at 9°N, 104°W (Figure 1). The Washington, with co-principal investigators J. Orcutt, P. Buhl and T. Brocher aboard, left Rodman later this same day. At 2100Z lab watch began on Conrad.
- 5/21-5/27 - In transit from Panama to EPR. Weather is perfect - sunny, hot very calm seas. Sea Beam, 3.5 kHz, gravity and magnetic data were collected during transit. At 0400Z 5/27 the BGM-3 gravity meter gyro failed crashing both the BGM-3 and Sea Beam. J. Smith replaced the gyro with a spare and both instruments were back up by 0549Z 5/27.
- 5/27 - We arrived at the EPR in the early morning at 1445Z; began to deploy the MCS streamer. The streamer used in this experiment was a 2.4 km long, 48 channel Seismic Engineering streamer with a 50 m group interval. It is typically towed at 5 kts at a depth of 40 ft. The streamer was in good condition. One depth transducer had to be replaced and the streamer was balanced by adding additional weights. Deployment was completed by 2045Z. No further work was required on the streamer which remained in good trim throughout the cruise. Meanwhile Washington surveyed several of the planned ESP profiles using Sea Beam.

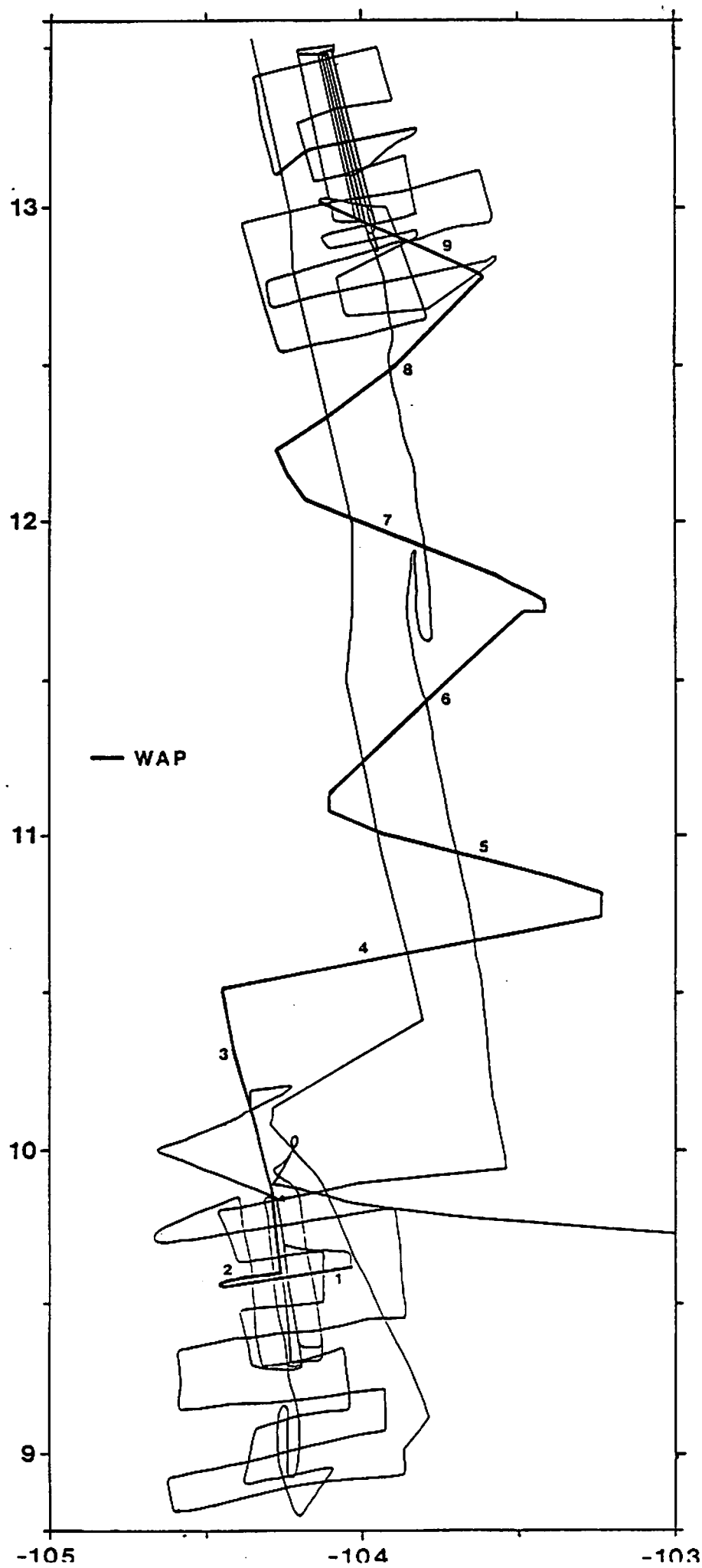


Figure 1

5/28-5/29 - The Conrad and Washington rendezvoused and began shooting the first ESP at 0100Z 5/28. At the pre-cruise meeting in Panama it had been agreed to shoot the ESPs from the endpoints in toward the midpoint with air guns, while using explosives from the midpoint out to ranges of about 50 km. The explosives were 60lb TOVEX charges fired in a 6 min interval. For the air gun work Washington used four guns (2x550 in³, 1x585 in³ and 1x460 in³) fired on a one-minute schedule. Conrad recorded on a DFS IV using 39 s records with a 4 ms sample interval and a 62 Hz anti-aliasing filter. Tom Brocher's analysis of bubble pulse periods for Washington's explosive shots indicated that most of the shots detonated at depths of 60±5 m with bubble pulse frequencies of 5.5-6.5 Hz. Sonobuoy #1 (see Table 4) recorded the source signature of the Washington air gun array and the air guns used by Conrad in the wide aperture profiling.

Eight ESPs were shot in the 9°30'N area (see Figure 2 for locations). ESPs 1-5 were shot using both explosives and air guns while ESPs 6-8 were shot only with air guns (Table 1). ESPs 1, 4 and 5 were well-navigated and the data quality looks excellent. On ESP 2 poor navigation resulted in the ships wandering up onto the ridge crest near the midpoint necessitating a reshoot of the air gun portion of this profile. During the explosive portion of this ESP both ships were back on the intended track 2.5 km west of the rise axis. During ESPs 1-3 the air guns aboard Washington were fired at only 1300 psi instead of 1800 psi. With this problem and the navigational difficulties on ESP 2 it was decided to reshoot ESPs 2 and 3 with air guns. During ESP 6 (the first reshoot of ESP 2) the gyro aboard the Washington failed and both ships ended up well west of the intended track at the midpoint. The second reshoot (ESP 7) went well as did the reshoot of ESP 3 (ESP 8).

5/30 - With the completion of the ESP work at 9°30'N the two ships reassembled to begin a long wide aperture profile north to the second study area at 13°N (Figure 1). The Conrad was the lead ship with the Washington following 5200 m behind. Washington fired the same air gun array used for the ESPs; the Conrad used its large conventional air gun array which consists of four 466 in³ air guns. Both ships fired their guns on a one minute schedule, alternatively every 30 s with Conrad firing on the minute and Washington firing on the half-minute. Conrad recorded 20 s records.

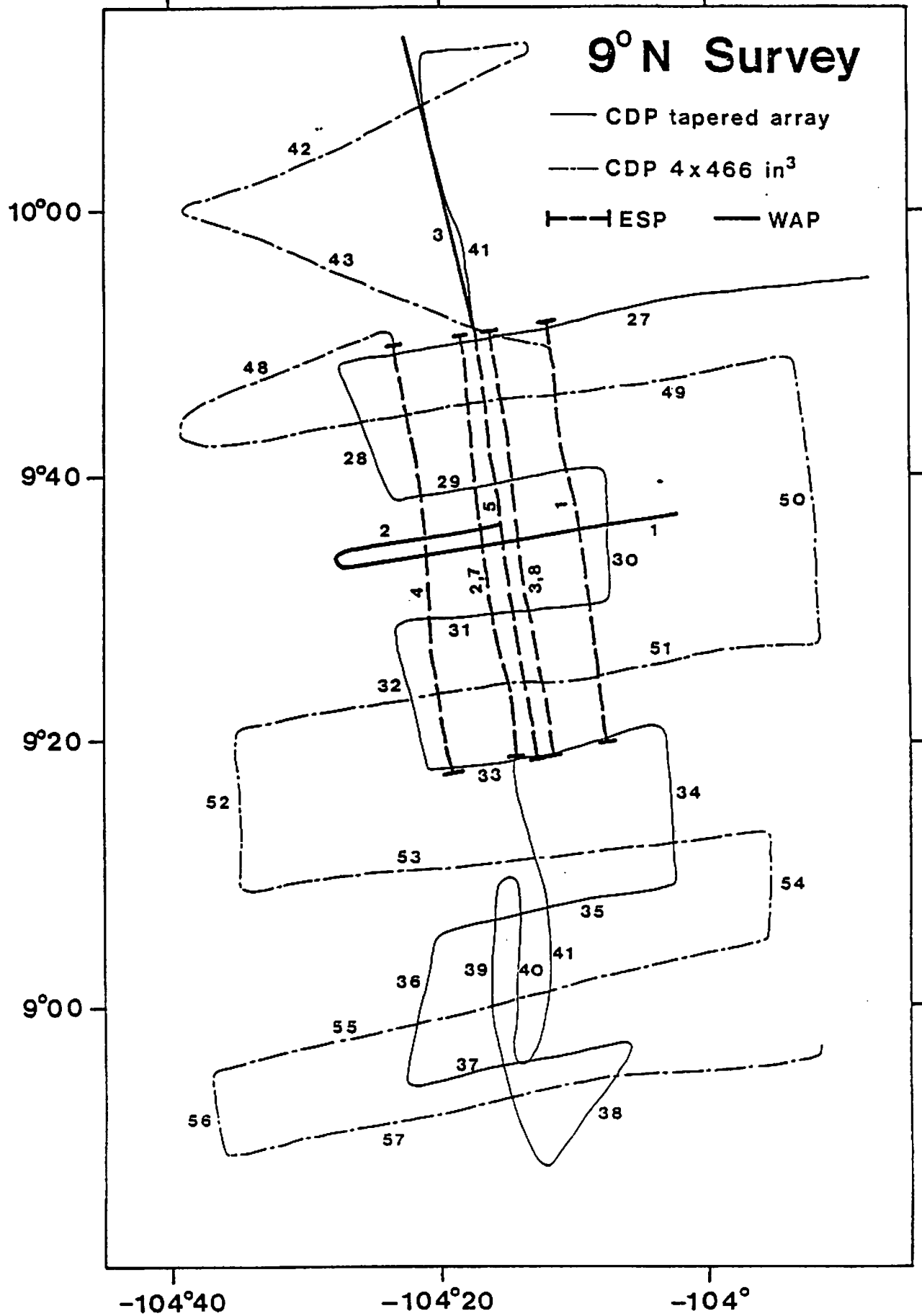


Figure 2

The first wide aperture profile (WAP 1, see Table 2) was shot across the EPR at about $9^{\circ}35'N$, near the midpoints of the ESPs. After a short line back to the ridge crest (WAP 2), we began a long wide aperture profile (WAP 3) northward along the crest of the EPR and across its western intersection with the Clipperton fracture zone. Around 0750Z on 5/30 a violent electrical storm passed through our area. At 0755Z the data logger crashed. Although it was up again by 0759Z, about 5 hrs later ($-1340Z$) we discovered that Conrad was firing every 30 s every other minute thus firing at the same time as the Washington half the time. The problem was finally solved by rebooting an older version of the data logging program at 1513Z 5/30. This problem will affect both WAP 2 and 3.

5/31-6/2 - Wide aperture profiling continued as we zigzagged across the EPR between the Clipperton fracture zone and $13^{\circ}N$ (Figure 1). Operationally these lines ran very smoothly. Some difficulty was encountered in maintaining the proper ship-to-ship range because Washington often had to alternate between its main and auxiliary engines. Apparently they had a problem with excessive oil consumption on the main engine when running at slow speeds. They thus preferred running on the auxiliary engine but had difficulty maintaining a speed of 5 kts against any significant current when using the auxiliary engine.

6/2-6/4 - About midday on 2 June we arrived at $13^{\circ}N$ and began the remaining ESP profiles. They were shot in a similar fashion to those at $9^{\circ}30'N$. Enough explosives remained for shooting only three ESPs; however, since we still had several more days for two-ship operations we agreed to shoot several additional air gun ESPs in this area.

ESP 9, the first shot in this area, was located along the rise crest while ESP 10 was located about 2.5 km to the west (Figure 3). Both ESPs were shot with air guns and explosives. In contrast to the EPR at $9^{\circ}30'N$ which is a broad, flat-topped high with gently sloping flanks, the rise axis here consists of a narrow, triangular-shaped high only about 1 km wide flanked by 1-2 km wide benches on either side and a deep, narrow V-shaped trough. ESP 9, positioned on the top of the axial high, displayed significant attenuation of amplitudes and higher frequency energy for both air gun and explosive shots beyond about 10-12 km range. In contrast, ESP 10, only 2.5 km away, displayed good refracted arrivals out to large ranges. These results appear to suggest that any crustal low velocity zone along this ridge segment must be quite narrow. To further constrain this, we positioned the last explosive ESP (ESP 11) between ESPs 9 and 10 on the bench only about 1 km west of the rise axis. Locating three ESPs within 2.5 km of the rise axis was possible only because of the distinctive

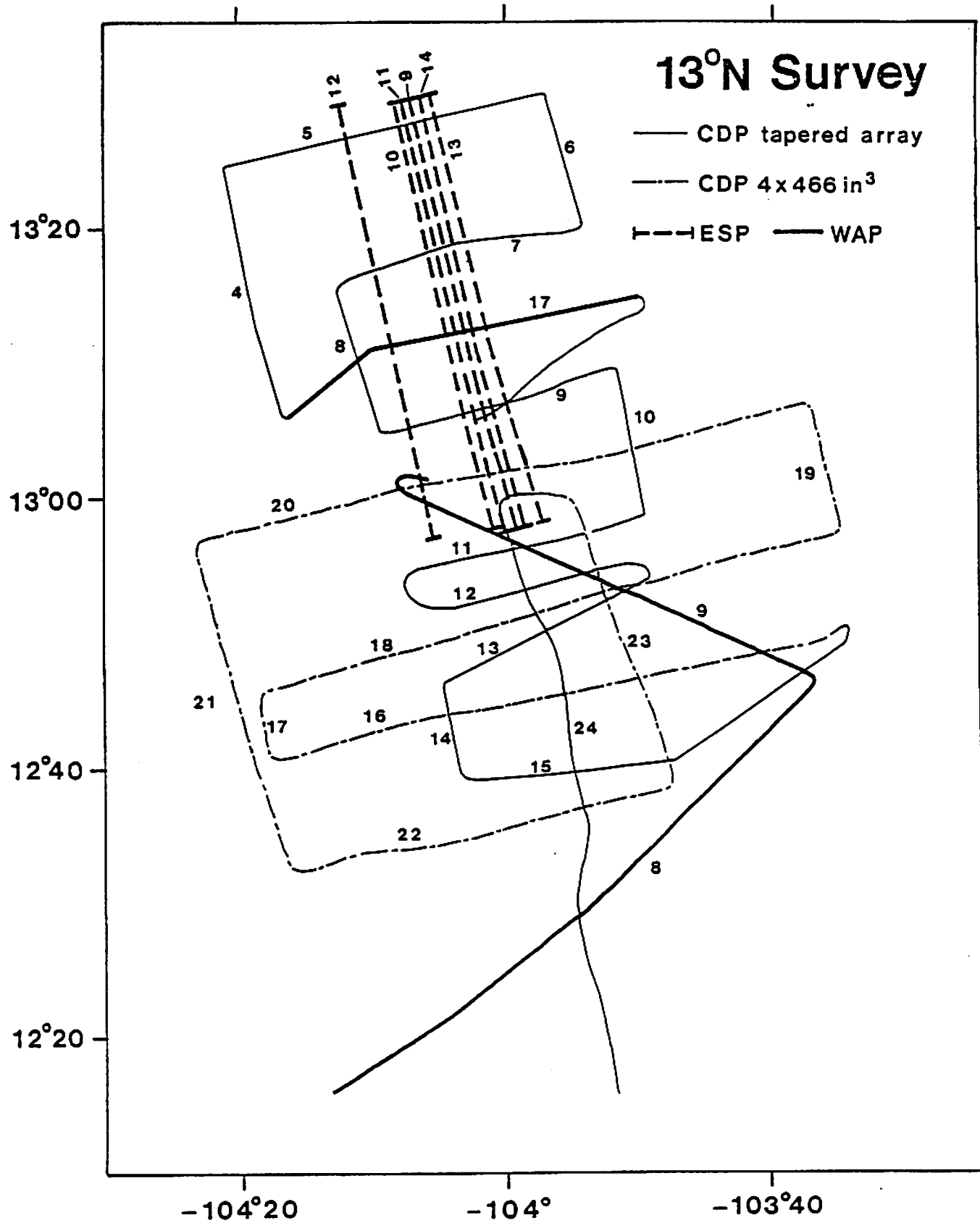


Figure 3

rise axis topography which we could accurately follow with the Sea Beam systems on both ships. ESP 11 also displayed significant attenuation of refracted energy beyond 10-12 km range. The remaining ESPs (12-14) were all shot only with air guns; two were located east of the rise axis to compliment the ESP shot to the west.

6/4-6/6 - Following the completion of ESP 14, wide aperture lines were obtained along each of the ESP profiles (WAP 10-15). After these lines were finished both ships deployed their tapered air gun arrays and two short wide aperture profiles (WAP 16 and 17) and two short air gun ESPs were shot. Conrad fired four air guns with chamber sizes of 235 in³, 350 in³, 500 in³ and 700 in³; Washington used guns of 825 in³, 585 in³, 466 in³ and 260 in³. Navigation problems existed on both ESPs with the ships wandering on and off the ridge.

After the completion of this work at about 2025Z 6/6, Washington and Conrad met to transfer gear (Raydist antenna and receiver, true time clock, air gun chambers, T-shirts, beer) before Washington departed for San Diego. The transfer of equipment and other items was completed by 2200Z and Conrad then began the single-ship CDP portion of the field program (Table 3).

6/7-6/9 - Two types of CDP lines across the rise axis were planned: six long (80 km) lines using the large conventional Conrad air gun array and six shorter (30 km) profiles using the tapered array. The line spacing was about 10 km. With a shot interval of 20 s and an average towing speed of 5 kts, the nominal shot spacing for the single-ship CDP work was 50 m resulting in 24-fold coverage. Since the tapered array was already in the water we began with the shorter lines working from north to south along the rise axis (Figure 3). Seven crossings of the EPR were obtained using the tapered array between 13° 40' N and 12° 41' N. (An extra crossing was obtained across the center of the overlapping spreading center (OSC) at 12° 50' N.)

Beginning in the early hours on Friday 7 June, the wind picked up with gusts up to 30-35 kts and conditions deteriorated significantly. The streamer was towed deeper, but was still somewhat noisy, possibly affecting the quality of CDP lines 7-10. By Saturday the 8th the wind died down and much more favorable sea conditions gradually developed. However, on Friday evening the Atlantis II informed us via ATS about tropical storm Blanca reported to be heading in our direction. By Saturday evening Blanca was a hurricane with 70 kt peak winds and gales up to 80 mi from center. The predicted path of the storm, still at this point about 400 mi away, would take it just north of our survey area.

Curiously, however, during Saturday and much of Sunday our weather conditions remained quite good with light winds, calm seas and high barometric pressure. Throughout the weekend and until we finally departed the area early on Monday, we were handicapped in our planning by the lack of accurate weather reports. This was compounded by poor reception on the antiquated single side band radio on the bridge.

Although the deteriorating weather conditions, including a rapidly building swell from Hurricane Blanca, eventually forced us to break off the survey in this area and head south early on the 10th, we were able to obtain four long lines across the EPR between $13^{\circ}02'N$ and $12^{\circ}40'N$ (Figure 3). However, the two long profiles planned for the northernmost portion of the area had to be abandoned. Thus, in total, we were able to obtain 12 CDP profiles across the EPR between $13^{\circ}40'N$ and $12^{\circ}40'N$ along with 8 ESPs, five of which are located within 2.5 km of the rise axis.

6/10-6/11 - After completing the final CDP profile across the EPR in the northern area we again changed gun chambers to the tapered array (under rather arduous conditions) and swung north to the EPR rise axis near $13^{\circ}N$, the southern end of the rise axis ESP. Our plan was to steam along the axis of the EPR all the way from $13^{\circ}N$ to the Clipperton fracture zone using Sea Beam to precisely maintain our position atop the axial high. Every 2-3 hrs SSQ57A sonobuoys would be deployed to provide some velocity control.

This line (CDP 24) was quite successful. Not only did we find it relatively easy to keep on top of the rise axis using Sea Beam, but at least at one point (between 1530-1900Z 6/10) an event about 600 ms below the seafloor was observed on the single channel monitor record that may be a magma chamber reflection. At the large $11^{\circ}45'N$ OSC we followed the eastern ridge segment until it ended then swung north through the overlap basin (CDP 25), picked up the western rise axis and continued to follow it south toward the Clipperton fracture zone (CDP 26). We hope this survey will provide some control on the crustal structure of this large OSC. CDP 26 south to the Clipperton was also quite successful and another prominent event -0.5 s below the sea floor was observed on the single channel monitor record between 0615Z and 0800Z on 6/11. At 2157Z on 6/11 we crossed the Clipperton fracture zone and turned west toward the southern survey area. In total, CDP lines 24 and 26 traverse almost a 300 km length of the EPR from $13^{\circ}N$ to the Clipperton fracture zone and should provide some unique constraints on along-strike variability of the EPR axial magma chamber.

Although all shipboard equipment had worked nearly flawlessly to this point, late on 11 June we had our first major equipment

problem when the power supply on the Magnavox GPS unit failed. With no spares available, the unit could not be repaired. The loss of 8 hrs of GPS coverage each day was very unfortunate.

6/12-6/13 - Like at 13°N our strategy in the southern survey area was to run 6 short (30 km) lines with the tapered array and 6 longer (80 km) lines with the conventional array. Since the tapered array was in the water we began with the short lines working our way from north to south (Figure 2). All six profiles were completed by 1530Z in 6/13. The only serious problem was with the diesel drive on one of the air gun compressors. It had to be taken off line about 0155Z on the 13th and the back-up direct AC drive could not maintain our nominal operating pressure of 1850 psi. The remainder of CDP 33 and CDP 34-41 were shot with 1600-1700 psi air. The diesel drive was repaired and brought back on line again about 2000Z 6/14.

6/14 - After finishing the short E-W CDP lines we swung back toward the rise axis, completed a brief survey of the 9°N OSC similar to that described for the OSC at $11^{\circ}45'\text{N}$ and then continued to run along the rise axis north to the Clipperton fracture zone. Between 0105Z and 0259Z the data logger crashed three times, although each time it was back up within 5 min. The cause of these crashes is not known. This line (CDP 41) was probably the most spectacular profile we collected. A reflection -0.6-1.0 s below the sea floor is observed along almost this entire profile, but especially between 0830Z and 1500Z (near the intersection of the MIK, MOK, SASHA seamount chain with the EPR). This reflection appears to have a reversed polarity relative to the sea floor reflection and is also clearly observed on several sonobuoys along this line (Sonobuoys 52, 53, 55, 56).

After crossing the Clipperton fracture zone we rendezvoused with Atlantis II and transferred a multiplexer board and A/D board to them for their Sea Beam system. At this time we also changed from the tapered air gun array to the 4x466 in³ air guns. After the transfer was completed we headed southwest toward MOK seamount. We then shot a CDP line across MOK, MIB and SASHA seamounts crossing the EPR near $9^{\circ}50'\text{N}$. The topography along this profile was extremely rugged. One sonobuoy deployment was made in the central portion of MOK.

6/15 - At 0501Z we began the CDP reshoots of the ESPs in this area working from east to west. Although transit satellite fixes were often infrequent, we were able to successfully use the Sea Beam bathymetry to stay on or close to the desired track. These four profiles (CDPs 44-47) were completed at 0614Z 16 June.

6/16-6/18 - Following completion of the ESP reshoots we began the final phase of our survey in this area which was the collection of five long (80 km) profiles across the rise axis between 9°45'N and 8°53'N. Operationally these lines went well except on CDP 51 when one of the compressors went off-line between 0406-0453Z 17 June for repairs. During this period only two guns were firing. Unfortunately, this corresponded with the rise axis crossing. An air gun also failed at 1115Z 17 June but was back on-line by 1250Z. This occurred near the western end of CDP 53 and will not affect the rise axis crossing.

The final line was completed at 1311Z 18 June and the recovery of the MCS gear began immediately. During recovery of the streamer the two stretch sections at the head of the streamer were replaced. The white radar reflector was lost from the tail buoy during recovery. Two sections had holes that were also repaired. Otherwise the streamer was in excellent condition. All MCS gear was aboard by 1754Z.

At about 1600Z, while the streamer was being recovered, a major problem developed with the generator on one of the ship's main engines. A bearing in the generator was melted and welded onto a shaft. An assessment of the damages indicated that the problem was repairable and the engine was operational again by 2355Z.

6/19-6/21 - At about 2000Z 19 June we rendezvoused a second time with the Atlantis II to get back the Sea Beam computer A/D board loaned to them earlier. Having completed this transfer we began our transit to Manzanillo. Between the Clipperton and Orozco fracture zones we ran parallel and 25 km west of the EPR in order to provide some off-axis Sea Beam data in this area. We asked Fox to run a second line 7 km west of the EPR on his transit to Manzanillo. Sea Beam was turned off and the lab secured at 0625Z 21 June. We docked at Manzanillo, Mexico on the morning of the 21st.

Summary

By any standards, RC 26-07 was an extremely successful cruise. We recorded a total of 1893 nm of CDP reflection data, about a third of which was obtained as wide aperture data. We obtained 30 new crossings of the EPR and a unique series of CDP lines along more than 500 km at the EPR crest between 8°50'N and 13°30'N. Detailed CDP surveys were also made of overlapping spreading centers at 9°N, 11°50'N and 12°55'N. Additional CDP lines were obtained across both Clipperton ridge transform intersections and several near-axis seamounts. Control on the crustal velocity structure will be available from 16 two-ship Expanding Spread Profiles and 74 sonobuoys. In the 13°N area, five ESPs were located within ± 2.5 km of the rise axis and should provide excellent constraints on the width of the axial magma chamber. The Sea Beam, gravity and magnetic data recorded throughout the survey are also valuable and unique data sets that should provide additional constraints on the crustal structure and tectonics of the EPR.

Recommendations

The following are some suggested improvements for R/V Conrad that would enhance its capabilities in these kinds of studies:

1. Larger air gun source array - On this cruise we used both Conrad's conventional 4x466 in³ air gun array and a "tapered" array consisting of four guns of different chamber sizes. There were major trade offs between these two arrays. The conventional array is a powerful low frequency energy source, but has a long bubble pulse train. The tapered array has a cleaner, more impulsive source but apparently less energy. A larger air gun source array (10 guns or more) would represent a major improvement over the current system in that it would make it feasible to have both a high energy and impulsive (broadband) source. Upgraded compressor capacity, gun fire control system and gun depth monitoring units are also required.
2. Shipboard processing capability - Some type of shipboard/basic MCS processing capability would have been extremely useful in order to make real-time decisions at sea regarding the placement of survey lines.
3. Direct drive AC motor - The back-up direct drive AC motor on the air gun compressor cannot maintain pressure when firing four air guns. It should be replaced or additional compressor capacity obtained.
4. Individually controllable birds - Needed for keeping streamer towing at proper depth.
5. Streamer/stern information on bridge - A repeater with streamer depth information on the bridge would be very useful in maintaining the proper towing speed. A video monitor viewing the stern would assist the bridge in watching cable angles during turns.
6. Maneuvering box on starboard wing of bridge - Needs to be moved so bearings can be taken during starboard-starboard ESP crossings.
7. Magnavox GPS receiver - Should be properly spared aboard ship; documentation needs to be improved.
8. Data logger - This system crashed numerous times without obvious cause. Although the system worked adequately it is in serious need of upgrading and integration with the VAX system now aboard ship.
9. Spare gyros - This is still the Achilles heel of Sea Beam. Adequate spares should always be available.

10. EGM-3 lab repeater - A repeater for the EGM-3 in the lab would be useful so it could be regularly checked by the watchstander.

11. Weather information - We were surprised at the poor quality of weather information available on the Conrad. Improvement here is definitely needed.

RC 26-07 Scientific Staff

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J. Smith (Science Officer)
J. Stennett (Sr. ET)

Luhl on Washington

Table 1. EPR EXPANDING SPREAD PROFILES, RC 26-07

Line #	Source	Time	START		MCS/Log Tape #	Time	END		MCS/Log Tape #
			Lat/Lon	Lat/Lon			Lat/Lon	Lat/Lon	
ESP 1	494	1.2	5/28/85 0100Z	9° 48.6 N 104 11.4 W	1762/202	5/28/85 0612Z	9° 20.3 N 104 07.5 W		1772/202
ESP 2	495	1.2	5/28/85 0820Z	9° 21.3 N 104 14.6 W	1773/202	5/28/85 1336Z	9° 46.3 N 104 17.7 W		1778/202
ESP 3	496	1.2	5/28/85 1500Z	9° 47.1 N 104 15.6 W	1784/202	5/28/85 1948Z	9° 20.1 N 104 11.4 W		1793/202
ESP 4	497	1.2	5/28/85 2216Z	9° 21.7 N 104 19.0 W	1794/202	5/29/85 0332Z	9° 47.7 N 104 22.9 W		1804/202
ESP 5	498	1.2	5/29/85 0530Z	9° 47.6 N 104 16.9 W	1805/202	5/29/85 1042Z	9° 20.2 N 104 12.8 W		1815/202
ESP 6	499	2	5/29/85 1200Z	9° 22.2 N 104 14.5 W	1816/202	5/29/85 1530Z	9° 39.6 N 104 19.0 W		1822/202
ESP 7	500	2	5/29/85 1650Z	9° 38.7 N 104 17.0 W	1823/202	5/29/85 1900Z	9° 27.1 N 104 15.3 W		1827/202
ESP 8	501	2	5/29/85 2029Z	9° 30.2 N 104 12.9 W	1828/202	5/29/85 2230Z	9° 40.7 N 104 14.5 W		1832/202
ESP 9	512	1.2	6/02/85 1758Z	13° 01.1 N 104 00.1 W	1992/206	6/02/85 2312Z	13° 01.1 N 104 06.4 W		2001/206
ESP 10	513	1.2	6/03/85 0019Z	13° 25.8 N 104 08.0 W	2002/206	6/03/85 0532Z	12° 58.4 N 104 00.9 W		2011/206
ESP 11	514	1.2	6/03/85 0700Z	13° 01.6 N 104 01.0 W	2012/206	6/03/85 1119Z	13° 27.1 N 104 07.2 W		2021/206

Line #	Source	Time	START Lat/Lon	MCS/Log Tape #	Time	END Lat/Lon	MCS/Log Tape #
ESP 12	515	2	6/03/85 1400Z	13 24.8 N 104 11.2 W	2022/206	6/03/85 1740Z	13 06.1 N 104 07.0 W 2029/206
ESP 13	516	2	6/03/85 1941Z	13 09.7 N 104 00.6 W	2030/206	6/03/85 2343Z	13 28.4 N 104 05.3 W 2037/206
ESP 14	517	2	6/04/85 0058Z	13 25.8 N 104 05.3 W	2038/207	6/04/85 0430Z	13 07.6 N 104 00.8 W 2044/207
ESP 15	526	3	6/06/85 0735Z	13 10.1 N 104 02.6 W	2124/207	6/06/85 950Z	13 20.8 N 104 06.1 W 2129/207
ESP 16	527	3	6/06/85 1137Z	13 18.2 N 104 03.6 W	2130/207	6/06/85 1340Z	13 18.2 N 104 01.3 W 2134/207

1 60lb TOVEX charges fired at 6 min intervals

2 Conventional air gun array - 2x550 in³, 1x585 in³ and 1x460 in³ - fire every 30 seconds

3 Tapered air gun array - 260 in³, 466 in³, 585 in³, 825 in³ - fired every 30 seconds

Table 2. EPR WIDE APERTURE PROFILES, RC 26-07

Line #	Source	Time	START		MCS/Log Tape #	Time	END		MCS/Log Tape #
			Lat/Lon	Lat/Lon			Lat/Lon	Lat/Lon	
WAP 1	503	1	5/30/85 0215Z	9° 36.0 N 104 04.6 W	1837/202	5/30/85 0633Z	9° 33.7 N 104 26.9 W		1846/202
WAP 2	504	1	5/30/85 0726Z	9 34.5 N 104 24.9 W	1847/203	5/30/85 0928Z	9 36.1 N 104 15.6 W		1851/204
WAP 3	505	1	5/30/85 1000Z	9 38.5 N 104 15.6 W	1851/204	5/30/85 2044Z	10 31.0 N 104 24.7 W		1872/206
WAP 4	506	1	5/30/85 2131Z	10 31.6 N 104 23.4 W	1873/206	5/31/85 1132Z	10 44.7 N 103 14.5 W		1900/206
WAP 5	507	1	5/31/85 1300Z	10 50.2 N 103 17.2 W	1901/206	5/31/85 2216Z	11 03.7 N 104 06.0 W		1919/206
WAP 6	508	1	5/31/85 2349Z	11 11.1 W 104 03.3 W	1920/206	6/01/85 0902Z	11 43.1 N 103 28.9 W		1938/206
WAP 7	509	1	6/01/85 1036Z	11 46.1 N 103 27.3 W	1939/206	6/01/85 1924Z	12 04.3 N 104 10.1 W		1956/206
WAP 8	510	1	6/01/85 2142Z	12 14.1 N 104 15.7 W	1957/206	6/02/85 0803Z	12 46.0 N 103 36.0 W		1978/206
WAP 9	511	1	6/02/85 0852Z	12 48.1 N 103 40.4 W	1979/206	6/02/85 1438Z	13 00.4 N 104 07.3 W		1991/206
WAP 10	519	1	6/04/85 2049Z	13 00.6 N 104 00.5 W	2049/207	6/04/85 1410Z	13 29.8 N 104 07.4 W		2061/207
WAP 11	520	1	6/04/85 1541Z	13 26.9 N 104 11.7 W	2062/207	6/04/85 2100Z	12 57.6 N 104 05.1 W		2072/207

Line #	Source	Time	START Lat/Lon	MCS/Log Tape #	Time	END Lat/Lon	MCS/Log Tape #
WAP 12	521	1	6/04/85 2220Z	13 00.6 N 104 01.6 W	2073/207	6/05/85 0408	13 28.0 N 104 08.1 W 2084/207
WAP 13	522	1	6/05/85 0525Z	13 25.6 N 104 04.3 W	2085/207	6/05/85 1023Z	13 01.1 N 103 58.7 W 2094/207
WAP 14	523	1	6/05/85 1130Z	13 00.6 N 104 01.2 W	2095/207	6/05/85 1740Z	13 28.8 N 104 07.8 W 2107/207
WAP 15	524	1	6/05/85 1824Z	13 27.2 N 104 05.6 W	2108/207	6/05/85 2340Z	12 59.1 N 103 58.9 W 2118/207
WAP 16	525	2	6/06/85 0225Z	12 58.1 N 103 59.7 W	2119/207	6/06/85 0458Z	13 11.1 N 104 02.8 W 2123/207
WAP 17	528	2	6/06/85 1700Z	13 14.4 N 103 51.9 W	2135/207	6/06/85 2026Z	13 11.2 N 104 09.5 W 2143/207

1 Conventional air gun arrays: CONRAD 4x466 in³; WASHINGTON 2x550 in³, 1x585 in³, 1x460 in³

2 Tapered air gun arrays: CONRAD 235 in³, 350 in³, 500 in³, 700 in³
WASHINGTON 260 in³, 466 in³, 585 in³, 825 in³

All air gun shots fired on a one minute schedule alternatively every 30 seconds.

Table 3. EPR CDP PROFILES, RC 26-07

CDP	Line #	source	Time	START		MCS/Log Tape #	Time	END		MCS/Log Tape #
				Lat/Lon	Lat/Lon			Lat/Lon	Lat/Lon	
CDP 1	502	1	5/29/85 2320Z	9 40.2' N 104 11.5 W	9 40.2' N 104 11.5 W	1833/202	5/30/85 0136Z	9 38.6' N 104 01.8 W		1836/202
CDP 2	518	1	6/04/85 0501Z	13 04.7 N 104 00.4 W	13 04.7 N 104 00.4 W	2045/207	6/04/85 0632Z	12 56.5 N 103 58.1 W		2048/207
CDP 3	529	2	6/06/85 2027Z	13 11.2 N 104 09.6 W	13 11.2 N 104 09.6 W	2144/207	6/06/85 2054Z	13 09.7 N 104 11.5 W		2144/207
CDP 4	530	2	6/06/85 2227Z	13 07.7 N 104 16.9 W	13 07.7 N 104 16.9 W	2145/207	6/07/85 0158Z	13 24.3 N 104 20.8 W		2151/207
CDP 5	531	2	6/7/85 0210Z	13 24.9 N 104 20.0 W	13 24.9 N 104 20.0 W	2152/207	6/07/85 0635Z	13 30.2 N 103 57.3 W		2160/207
CDP 6	532	2	6/07/85 0649Z	13 29.4 N 103 56.6 W	13 29.4 N 103 56.6 W	2161/207	6/07/85 0829Z	13 20.5 N 103 54.4 W		2164/207
CDP 7	533	2	6/07/85 0900Z	13 19.3 N 103 56.6 W	13 19.3 N 103 56.6 W	2165/207	6/07/85 1209Z	13 16.1 N 104 12.1 W		2171/207
CDP 8	534	2	6/07/85 1229Z	13 14.6 N 104 12.1 W	13 14.6 N 104 12.1 W	2172/208	6/07/85 1421Z	13 05.2 N 104 09.6 W		2175/208
CDP 9	535	2	6/07/85 1429Z	13 05.2 N 104 09.0 W	13 05.2 N 104 09.0 W	2176/208	6/07/85 1722Z	13 08.8 N 103 53.5 W		2181/208
CDP 10	536	2	6/07/85 1730Z	13 08.1 N 103 52.9 W	13 08.1 N 103 52.9 W	2182/208	6/07/85 1925Z	12 58.4 N 103 51.3 W		2185/208
CDP 11	537	2	6/07/85 1935Z	12 57.8 N 103 51.7 W	12 57.8 N 103 51.7 W	2186/208	6/07/85 2248Z	12 54.7 N 104 07.2 W		2191/208

	Line #	Source	Time	START Lat/Lon	MCS/Log Tape #	Time	END Lat/Lon	MCS/Log Tape #
CDP 12	538	2	6/07/85 2339Z	12 52.2 N 104 05.1 W	2192/208	6/08/85 0212Z	12 55.3 N 103 50.5 W	2196/208
CDP 13	539	2	6/08/85 0234Z	12 54.1 N 103 49.4 W	2197/208	6/08/85 0540Z	12 46.8 N 104 04.3 W	2202/208
CDP 14	540	2	6/08/85 0549Z	12 45.9 N 104 04.5 W	2203/208	6/08/85 0650Z	12 40.2 N 104 03.0 W	2204/208
CDP 15	541	2	6/08/85 0715Z	13 34.8 N 104 01.0 W	2205/208	6/08/85 1211Z	12 46.5 N 103 38.4 W	2214/208
CDP 16	542	1	6/08/85 1410Z	12 48.9 N 103 37.2 W	2215/209	6/08/85 2059Z	12 40.7 N 104 16.6 W	2227/209
CDP 17	543	1	6/08/85 2114Z	12 41.4 N 104 17.5 W	2228/209	6/08/85 2206Z	12 45.6 N 104 18.1 W	2229/209
CDP 18	544	1	6/08/85 2230Z	12 46.2 N 104 16.6 W	2230/209	6/09/85 0730Z	12 57.2 N 103 36.2 W	2246/209
CDP 19	545	1	6/09/85 0742Z	12 58.0 N 103 35.9 W	2247/209	6/09/85 0922Z	13 06.1 N 103 38.5 W	2250/209
CDP 20	546	1	6/09/85 0945Z	13 06.2 N 103 40.5 W	2251/209	6/09/85 1735Z	12 56.9 N 104 21.9 W	2265/209
CDP 21	547	1	6/09/85 1747Z	12 55.9 N 104 22.3 W	2266/209	6/09/85 2308Z	12 33.3 N 104 16.3 W	2273/210
CDP 22	548	1	6/09/85 2245Z	12 33.5 N 104 12.9 W	2274/210	6.10/85 0330Z	12 38.4 N 103 48.1 W	2282/210
CDP 23	549	1	6/10/85 0448Z	12 43.5 N 103 48.8 N	2283/210	6/10/85 0845Z	12 59.2 N 103 54.5 W	2290/210

	Line #	Source	Time	START Lat/Lon	MCS/Log Tape #	Time	END Lat/Lon	MCS/Log Tape #
CDP 24	550	2	6/10/85 1020Z	12 57.6 N 103 59.3 W	2291/210	6/10/85 2331Z	11 38.2 N 103 46.5 W	2316/210
CDP 25	551	2	6/11/85 0032Z	11 40.4 N 103 49.0 W	2317/211	6/11/85 0310Z	11 53.3 N 103 49.7 W	2321/211
CDP 26	552	2	6/11/85 0400Z	11 52.1 N 103 50.2 W	2322/211	6/12/85 0233Z	9 56.6 N 103 32.1 W	2364/211
CDP 27	553	2	6/12/85 0323Z	9 55.7 N 103 36.2 W	2365/211	6/12/85 1300Z	9 48.6 N 104 27.2 W	2383/211
CDP 28	554	2	6/12/85 1312Z	9 47.9 N 104 27.4 W	2384/211	6/12/85 1505Z	9 38.5 N 104 23.5 W	2387/211
CDP 29	555	2	6/12/85 1515Z	9 38.3 N 104 22.7 W	2388/211	6/12/85 1808Z	9 40.9 N 104 08.0 W	2393/211
CDP 30	556	2	6/12/85 1827Z	9 39.6 N 104 07.4 W	2394/211	6/12/85 2000Z	9 30.8 N 104 07.0 W	2396/211
CDP 31	557	2	6/12/85 2018Z	9 30.3 N 104 08.3 W	2397/211	6/12/85 2303Z	9 28.9 N 104 22.6 W	2401/211
CDP 32	558	2	6/12/85 2340Z	9 25.9 N 104 22.8 W	2402/211	6/13/85 0107Z	9 18.5 N 104 20.8 W	2404/211
CDP 33	559	2	6/13/85 0130Z	9 18.3 N 104 19.0 W	2405/211	6/13/85 0422Z	9 20.2 N 104 05.0 W	2409/211
CDP 34	560	2	6/13/85 0438Z	9 19.4 N 104 08.4 W	2410/213	6/13/85 0643Z	9 08.4 N 104 03.6 W	2413/213
CDP 35	561	2	6/13/85 0706Z	9 07.6 N 104 05.3 W	2414/213	6/13/85 1014Z	9 05.6 N 104 19.8 W	2419/213
CDP 36	562	2	6/13/85 1026Z	9 04.7 N 104 20.7 W	2420/213	6/13/85 1223Z	8 54.7 N 104 23.0 W	2423/213

	Line #	Source	START		MCS/Log Tape #		END			MCS/Log Tape #
			Time	Lat/Lon			Time	Lat/Lon		
CDP 37	563	2	6/13/85 1250Z	8 54.3 N 104 20.5 W	2424/213		6/13/85 1532Z	8 57.2 N 104 06.5 W		2428/213
CDP 38	564	2	6/13/85 1547Z	8 56.1 N 104 06.5 W	2429/213		6/13/85 1740Z	8 48.2 N 104 11.6 W		2432/213
CDP 39	565	2	6/13/85 1805Z	8 49.2 N 104 12.9 W	2433/213		6/13/85 2200Z	9 08.8 N 104 15.3 W		2440/213
CDP 40	566	2	6/13/85 2248Z	9 07.1 N 104 14.0 W	2441/213		6/14/85 0102Z	8 56.5 N 104 14.4 W		2444/213
CDP 41	567	2	6/14/85 0137Z	8 57.3 N 104 12.6 W	2445/214		6/14/85 1600Z	10 11.2 N 104 21.2 W		2472/216
CDP 42	568	1	6/14/85 1830Z	10 09.4 N 104 18.3 W	2473/216		6/14/85 2304Z	9 09.4 N 104 38.9 W		2481/216
CDP 43	569	1	6/14/85 2300Z	9 59.1 N 104 37.4 W	2482/216		6/15/85 0437Z	9 49.4 N 104 12.4 W		2491/216
CDP 44	570	1	6/15/85 0501Z	9 48.0 N 104 11.4 W	2492/217		6/15/85 1038Z	9 22.1 N 104 07.8 W		2501/217
CDP 45	571	1	6/15/85 1140Z	9 23.3 N 104 11.9 W	2502/217		6/15/85 1653Z	9 50.3 N 104 16.5 W		2511/217
CDP 46	572	1	6/15/85 1730Z	9 48.8 N 104 18.2 W	2512/217		6/15/85 2304Z	9 20.0 N 104 13.6 W		2521/217
CDP 47	573	1	6/16/85 0030Z	9 20.4 N 104 19.2 W	2522/217		6/16/85 0614Z	9 49.8 N 104 23.1 W		2532/217
CDP 48	574	1	6/16/85 0645Z	9 49.3 N 104 25.4 W	2533/217		6/16/85 0918Z	9 44.0 N 104 38.5 W		2538/217
CDP 49	575	1	6/16/85 1030Z	9 42.2 N 104 36.0 W	2539/217		6/16/85 1814Z	9 47.9 N 104 55.2 W		2553/217

	Line #	Source	Time	START Lat/Lon	MCS/Log Tape #	Time	END Lat/Lon	MCS/Log Tape #
CDP 50	576	1	6/16/85 1845Z	9 46.1 N 103 54.7 W	2554/217	6/16/85 2313Z	9 27.6 N 103 51.8 W	2561/217
CDP 51	577	1	6/16/85 2340Z	9 26.9 N 103 53.2 W	2562/217	6/17/85 0850Z	9 19.9 N 104 35.1 W	2578/217
CDP 52	578	1	6/17/85 0900Z	9 19.1 N 104 35.1 W	2579/217	6/17/85 1038Z	9 09.4 N 104 34.8 W	2581/217
CDP 53	579	1	6/17/85 1105Z	9 08.9 N 104 32.6 W	2582/217	6/17/85 1754Z	9 12.4 N 103 55.6 W	2594/218
CDP 54	580	1	6/17/85 1815Z	9 11.1 N 103 54.7 W	2595/218	6/17/85 1931Z	9 04.7 N 103 54.3 W	2597/218
CDP 55	581	1	6/17/85 1949Z	9 04.4 N 103 56.7 W	2598/218	6/18/85 0328Z	8 55.6 N 104 36.0 W	2611/218
CDP 56	582	1	6/18/85 0344Z	8 54.4 N 104 36.2 W	2612/218	6/18/85 0440Z	8 49.7 N 104 35.5 W	2613/218
CDP 57	583	1	6/18/85 0459Z	8 49.5 N 104 34.0 W	2614/218	6/18/85 1311Z	8 55.8 N 103 52.1 W	2629/218

- 1 Conventional air gun array - 4x466 in³ - fired every 20 seconds
- 2 Tapered air gun array - 235 in³, 350 in³, 5000 in³, 700 in³ - fired every 20 seconds

Table 4. EPR SONOBUOYS, RC 26-07

Sonobuoy #	Type	Ch	Time	Lat/Lon	Line #	MCS/Logger Tape #	Remarks*
1	57A	24	5/30/85 0315Z	9 36.0 N 104 09.4 W	503	1838/203	Gun signature test 400' hydrophone
2	57A	21	6/04/85 0825Z	13 02.9 N 104 01.1 W	511	2050/207	Southern end of ESP 9
3	57A	21	6/04/85 2228Z	13 01.3 N 104 01.8 W	519	2073/207	
4	57A	30	6/05/85 0158Z	13 18.4 N 104 05.4 W	521	2080/207	
5	57A	22	6/05/85 0629Z	13 20.4 N 104 03.1 W	522	2087/207	Northern portion ESP 13
6	57A	27	6/05/85 0838Z	13 09.4 N 104 00.8 W	522	2091/207	Southern portion ESP 13, lost signal -0900Z near R/V WASHINGTON
7	57A	19	6/05/85 0921Z	13 04.8 N 103 59.0 W	522	2092/207	Southern portion ESP 13, turned at 1022Z
8	57A	25	6/05/85 1246Z	13 06.6 N 104 02.2 W	523	2097/207	
9	57A	19	6/05/85 1514Z	13 17.8 N 104 04.9 W	523	2102/207	No signal
10	57A	31	6/05/85 1529Z	13 18.8 N 104 05.2 W	523	2103/207	
11	57A	20	6/05/85 1950Z	13 19.5 N 104 04.1 W	524	2110/207	

Sonobuoy #	Type	Ch	Time	Lat/Lon	Line #	MCS/Logger Tape #	Remarks*
12	57A	29	6/05/85 2159Z	13 08.3 N 104 01.2 W	524	2115/207	
13	41B	12	6/06/85 0335Z	13 04.0 N 104 00.9 W	525	2121/207	Source signature test: 400' phone
14	57A	30	6/06/85 2235Z	13 08.7 N 104 17.2 W	530	2145/207	Distorted signal from buoy
15	57A	23	6/07/85 0004Z	13 15.2 N 104 18.9 W	530	2147/207	
16	57A	15	6/07/85 0649Z	13 29.4 N 103 56.7 W	532	2161/207	
17	57A	-	6/07/85 1232Z	13 14.4 N 104 12.1 W	534	2172/208	Buoy caught by streamer and aborted
18	57A	31	6/07/85 1320Z	13 10.8 N 104 11.0 W	534	2173/208	
19	57A	22	6/07/85 1735Z	13 07.9 N 103 52.9 W	536	2182/208	
20	57A	29	6/08/85 0555Z	12 45.4 N 104 04.4 W	540	2203/208	
21	57A	24	6/09/85 0745Z	12 58.2 N 103 35.9 W	545	2247/209	
22	57A	26	6/09/85 1810Z	12 54.8 N 104 21.7 W	547	2266/210	
23	57A	29	6/10/85 1633Z	12 20.1 N 103 52.2 W	550	2302/210	

Sonobuoy #	Type	Ch	Time	Lat/Lon	Line #	MCS/Logger Tape #	Remarks*
24	57A	25	6/10/85 1817Z	12 09.5 N 103 48.6 W	550	2305/210	
25	57A	31	6/10/85 2030Z	11 56.2 N 103 45.5 W	550	2310/210	
26	57A	26	6/10/85 2210Z	11 46.1 N 103 46.3 W	550	2313/210	
27	57Z	27	6/11/85 0119Z	11 44.2 N 103 49.4 W	551	2318/211	
28	57A	29	6/11/85 0405Z	11 51.6 N 103 50.2 W	552	2322/211	
29	57A	30	6/11/85 0558Z	11 41.6 N 103 51.0 W	552	2325/211	
30	57A	27	6/11/85 0805Z	11 29.0 N 103 48.0 W	552	2329/211	
31	57A	18	6/11/85 1013Z	11 17.9 N 103 46.0 W	552	2334/211	No signal
32	57A	28	6/11/85 1044Z	11 15.3 N 103 45.4 W	552	2335/211	
33	57A	12	6/11/85 1240Z	11 04.9 N 103 43.5 W	552	2339/211	Caught by streamer
34	57A	9	6/11/85 1300Z	11 02.8 N 103 43.1 W	552	2339/211	
35	57A	27	6/11/85 1441Z	10 54.4 N 103 40.7 W	552	2342/211	Terminated due to radio interference
36	57A	17	6/11/85 1537Z	10 49.8 N 103 39.2 W	552	2344/211	

Sonobuoy #	Type	Ch	Time	Lat/Lon	Line #	MCS/Logger Tape #	Remarks*
37	57A	16	6/11/85 1728Z	10 40.3 N 103 38.4 W	552	2348/211	
38	57A	8	6/11/85 1925Z	10 30.3 N 103 37.2 W	552	2351/211	
39	57A	28	6/11/85 2355Z	10 09.0 N 103 34.3 W	552	2360/211	
40	57A	10	6/12/85 0115Z	9 47.4 N 104 27.2 W	552	2384/211	No signal
41	57A	13	6/12/85 1325Z	9 46.7 N 104 26.9 W	554	2384/211	Sonobuoy caught by streamer
42	57A	2	6/12/85 1358Z	9 44.1 N 104 25.9 W	554	2385/211	
43	57A	14	6/12/85 1836Z	9 38.9 N 104 07.3 W	556	2394/211	3 hour duration
44	57A	1	6/12/85 2342Z	9 25.7 N 104 22.7 W	558	2402/211	
45	57A	15	6/13/85 0500Z	9 17.4 N 104 04.1 W	560	2410/213	
46	57A	17	6/13/85 1028Z	9 04.5 N 104 20.3 W	562	2420/213	Poor arrivals
47	41B	10	6/13/85 1901Z	8 53.0 N 104 14.3 W	565	2434/213	Recorded on auxiliary channel 3
48	57A	3	6/13/85 1901Z	8 53.0 N 104 14.3 W	565	2434/213	Failed at 1903Z
49	57A	28	6/13/85 1904Z	8 53.9 N 104 14.4 W	565	2434/213	

Sonobuoy #	Type	Ch	Time	Lat/Lon	Line #	MCS/Logger Tape #	Remarks*
50	57A	16	6/13/85 2049Z	9 02.8 N 104 15.7 W	565	2438/213	
51	57A	1	6/14/85 0217Z	9 00.8 N 104 11.9 W	567	2446/215	No shots between 0258-0305Z
52	57A	8	6/14/85 0622Z	9 29.0 N 104 13.9 W	567	2453/216	3 hour duration
53	57A	12	6/14/85 0812Z	9 29.4 N 104 14.0 W	567	2457/216	3 hour duration
54	57A	2	6/14/85 0941Z	9 36.8 N 104 15.2 W	567	2460/211	Sonobuoy caught by streamer
55	57A	5	6/14/85 0959Z	9 38.4 N 104 15.6 W	567	2460/216	
56	57A	13	6/14/85 1145Z	9 47.9 N 104 16.9 W	567	2464/216	Strong reflection 0.7 s below sea floor
57	57A	28	6/14/85 1327Z	9 57.1 N 104 18.8 W	567	2467/216	
58	57A	4	6/14/85 1455Z	10 05.3 N 104 20.3 W	567	2470/216	Recorded on auxiliary channel 3
59	57A	14	6/14/85 2350Z	9 58.6 N 104 35.8 W	569	2482/216	
60	57A	11	6/15/85 0507Z	9 47.5 N 104 11.3 W	570	2492/217	
61	57A	5	6/15/85 0705Z	9 37.8 N 104 09.8 W	570	2495/217	
62	57A	9	6/15/85 0915Z	9 28.5 N 104 08.1 W	570	2499/217	

Sonobuoy #	Type	Ch	Time	Lat/Lon	Line #	MCS/Logger	Tape #	Remarks*
63	57A	4	6/15/85 1141Z	9 23.4 N 104 11.9 W	571	2502/217		
64	57A	7	6/15/85 1432Z	9 39.0 N 104 14.1 W	571	2507/217		
65	57A	11	6/15/85 1820Z	9 44.6 N 104 17.6 W	572	2513/217		Failed after 10 minutes
66	57A	7	6/15/85 1832Z	9 43.7 N 104 17.5 W	572	2513/217		
67	57A	6	6/15/85 2056Z	9 31.9 N 104 15.9 W	572	2518/217		
68	57A	10	6/16/85 0057Z	9 22.8 N 104 19.5 W	573	2522/217		
69	57A	6	6/16/85 0355Z	9 37.5 N 104 21.0 W	573	2528/217		
70	41B	13	6/16/85 1943Z	9 41.8 N 103 54.2 W	576	2555/217		New model
71	57A	22	6/17/85 0910Z	9 18.3 N 104 35.1 W	578	2579/217		
72	57A	28	6/17/85 0926Z	9 09.4 N 104 34.8 W	578	2579/217		
73	41B	5	6/17/85 1815Z	9 11.0 N 103 54.7 W	580	2595/218		New model
74	41B	1	6/18/85 0345Z	8 54.3 N 104 36.2 W	582	2612/218		

*60' hydrophone unless otherwise indicated

Appendix 1

Measurement of Distances on R/V CONRAD and R/V WASHINGTON

R/V WASHINGTON

From 1/8" = 1' Plans on the Washington

Miniranger to stern - 72' (22 m)

Raydist to stern - 48' (14.6 m)

Bridge compasses to Miniranger - 84.5' (25.76 m)

Measured on deck using 12' tape rule

Miniranger to stern - 79'5" (24.2 m)

Raydist to stern 45'9" (13.9 m)

Shooting table to stern - 31'9" (9.7 m)

Length of shot streamer hydrophone from stern - 181' (55.2 m)

Shooting table to shot hydrophone - 212.75' (64.9 m)

A/6 towed from stern:

Starboard - 75' (22.9 m) (width 550")

Inside starboard - 50' (15.2 m) (width 466')

Inside port - 75' (22.9 m) (width 550")

Port - 50' (15.2 m) (width 585")

Depth of shot streamer is unknown -estimated as 5 m by Perry Crampton

Appendix 2

CONRAD to WASHINGTON Bearing Angles for ESPs

ESP #1 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
5/28/85	0336Z	172°	0349Z	013°
	0337	172	0350	009
	0338	172	0351	006
	0339	172.5	0352	004
	0340	-	0353	002
	0341	169	0354	001.5
	0342	163	0355	001
	0343	153	0356	359.5
	0344	133	0357	358.5
	0345	095	0358	358
	0346	055	0359	357
	0347	032	0400	356.5
	0348	020	0401	355.5

0345Z Ships abeam .21 mi radar
 Miniranger reading 415 yd

ESP #2 Starboard to Starboard Crossing

	Time	Bearing	Time	Bearing
5/28/85	1048Z	356°	1058Z	0320
	1049	356.5	1059	065
	1050	356.5	1100	104
	1051	357	1101	127
	1052	358	1102	138
	1053	358	1103	145
	1054	359	1104	149.5
	1055	001	1105	152.5
	1056	006	1106	156
	1057	015.5	1107	Blocked
	1059Z	Ships abeam	0.2 mi radar	

ESP #3 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
5/28/85	1705Z	147 ⁰	1718	040 ⁰
	1706	145	1719	027
	1707	144	1720	017.5
	1708	141.5	1721	011.5
	1709	140	1722	007.0
	1710	137.5	1723	002.5
	1711	134	1724	000.5
	1712	128.5	1725	358
	1713	121	1726	356
	1714	111	1727	356
	1715	107	1728	356
	1716	78.5	1729	356
	1717	58	1730	356
	1716Z	Ships abeam	0.6 mi radar	
		Miniranger reading	1250 yd	

ESP #4 Port-to Port Crossing

	Time	Bearing	Time	Bearing
5/29/85	0030Z	345 ⁰	00447	311 ⁰
	0031	344	0048	302
	0032	344	0049	289
	0033	343	0050	273
	0034	342	0051	255
	0035	342	0052	238
	0036	341	0053	225
	0037	340	0054	216
	0038	339	0055	208
	0039	338	0056	203
	0040	337	0057	199
	0041	335	0058	196
	0042	333	0059	193
	0043	331	1900	191
	0044	328	1901	189
	0045	324	1902	188
	0046	319	1003	187
		Ships abeam	0.55 mi radar	
		Miniranger reading	1138 yd	

ESP #5 Starboard-to-Starboard Crossing

	Time	Bearing	
5/29/85	0750Z	190°	
	0751	190	
	0759	201	
	0800	203	
	0801	209	
	0802	212	
	0803	221	
	0804	231	
	0805	243	
	0806	260	
	0807	278	
	0808	292	
	0809	304	
	0810	311	
	1811	317	
	0801Z	Ships abeam	0.6 mi radar

ESP #6 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
5/29/85	1406Z	354°	1424Z	218°
	1407	354	1425	207
	1410	354	1426	201
	1415	353	1427	196
	1416	352	1428	193
	1417	349	1429	191
	1418	344	1430	189
	1419	335	1431	187
	1420	321	1432	186.5
	1421	297	1433	186
	1422	265	1434	186
	1423	237	1435	186
	1421Z	Ships abeam		

ESP #7 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
5/29/85	1742Z	170.5°	1757Z	39°
	1743	170.5	1758	28
	1744	170	1759	20
	1745	170	1800	16
	1746	169	1801	12
	1747	169	1802	9.5
	1748	168	1803	8
	1749	165	1804	5
	1750	159	1805	2
	1751	151	1806	359
	1752	140	1807	357
	1753	125	1808	356.5
	1754	116	1809	356
	1755	81	1810	356
	1756	56		

1755Z Ships abeam
 Miniranger reading 847 yd

ESP #8 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
5/29/85	2115Z	344°	2133Z	201°
	2116	343	2134	198
	2117	342	2135	196
	2118	342	2136	195
	2119	340.5	2137	193.5
	2120	339	2138	192
	2121	338	2139	190
	2122	336	2140	188
	2123	332	2141	185
	2124	326	2142	184
	2125	315	2143	182.5
	2126	297	2144	181
	2127	270.5	2145	180
	2128	244	2146	179
	2129	227	2147	179
	2130	216	2148	178.5
	2131	209	2149	177
	2132	204	2150	177

2126Z Ships abeam
 Miniranger reading 735 yd

ESP #9 Starboard-to-Starboard Crossing

Time	Bearing	Time	Bearing
2015Z	347°	2036Z	134°
2016	348	2037	142
2017	348.5	2038	-147*
2018	348	2039	-151*
2019	348	2040	-153*
2020	348.5	2041	-156*
2021	348.5	2042	-157*
2022	349	2043	-158*
2023	349	2044	-159*
2024	349.5	2045	-159*
2025	349.5	2046	159.5
2026	350	2047	160.5
2027	350	2048	161
2028	351	2049	161.5
2029	351	2050	162
2030	352	2051	162
2031	354	2052	163
2032	002	2053	163
2033	023	2054	163.5
2034	081	2055	163.5
2035	116		

2033Z Ships abeam
 Miniranger reading 330 yd

*Note: 2038-2045Z - Bearings are approximate; line of sight was blocked

ESP #10 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
6/03/85	0242Z	156 ⁰	0259	003.5 ⁰
	0243	154	0300	002
	0244	152	0301	000.5
	0245	149	0302	359.5
	0246	145.5	0303	359
	0247	140.5	0304	358
	0248	134	0305	357
	0249	121	0306	356
	0250	102	0307	356
	0251	076.5	0308	355.5
	0252	051.5	0309	355
	0253	034.5	0310	355
	0254	023.5	0311	355
	0255	016	0312	354
	0256	011	0313	354
	0257	008	0314	354
	0258	005.5		

0250Z Ships abeam
 Miniranger reading 750 yd

ESP #11 Port-to-Port Crossing (?)

	Time	Bearing	Time	Bearing
6/03/85	0924Z	346 ⁰	0937	291 ⁰
	0925	344	0938	226
	0926	344	0939	200
	0927	343	0940	189
	0928	343	0941	183
	0929	343	0942	180
	0930	342	0943	178
	0931	342	0944	176
	0932	341	0945	175
	0933	341	0946	174
	0934	340	0947	173
	0935	336	0948	172
	0936	324		

0297Z Ships abeam .11 mi radar
 Miniranger reading 230 yd

ESP #12 Port-to-Port Crossing (?)

	Time	Bearing	Time	Bearing	
6/03/85	1605Z	169 ⁰	1626Z	156 ⁰	
	1606	169	1627	142	
	1607	169	1628	114	
	1608	169	1629	075	
	1609	169	1630	043	
	1610	169	1631	025	
	1611	169	1632	015	
	1612	169	1633	9.5	
	1613	169	1634	6	
	1614	169.5	1635	3.5	
	1615	169	1636	1.5	
	1616	169.5	1637	0	
	1617	169.5	1638	358	
	1618	169.5	1639	357	
	1619	169.5	1640	356	
	1620	169.5	1641	355	
	1621	169.5	1642	354	
	1622	169.5	1643	353	
	1623	169	1644	353	
	1624	167.5	1645	352	
	1625	163	1646	352	
			1647	352	
		1628Z	Ships abeam		
		Miniranger reading	480 yd		

ESP #13 Starboard-to-Starboard Crossing

	Time	Bearing	Time	Bearing
6/03/85	2030Z	347 ⁰	0246Z	Blocked
	2031	347		
	2032	347		
	2033	347		
	2034	347		
	2035	347		
	2036	347		
	2037	347		
	2038	347		
	2039	347.5		
	2040	349		
	2041	350		
	2042	043		
	2043	127		
	2044	143		
	2045	149		
		2042Z	Ships abeam	

ESP #14 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
6/04/85	0310Z	161 ⁰	0326Z	051 ⁰
	0311	160	0327	031
	0312	160	0328	019
	0313	159	0329	012
	0314	158.5	0330	007
	0315	157	0331	003.5
	0316	156.5	0332	001
	0317	155	0333	359
	0318	153	0334	358
	0319	151	0335	356.5
	0320	148	0336	355.5
	0321	144	0337	354.5
	0322	137	0338	353.5
	0323	127	0239	353
	0324	109	0340	353
	0325	081		
		0325Z	Ships abeam	
		Miniranger reading	700 yd	

ESP #15 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
6/06/85	0830Z	340°	0841	247°
	0831	340	0842	220
	0832	338	0843	205
	0833	337	0844	196
	0834	336	0845	190
	0835	335	0846	185
	0836	334	0847	182
	0837	332	0848	180
	0838	323	0849	179
	0839	309	085	177
	0840	283		

ESP #16 Port-to-Port Crossing

	Time	Bearing	Time	Bearing
6/06/85	1222Z	160°	1239	81°
	1223	160.5	1240	55
	1224	161	1241	34
	1225	158.5	1242	23
	1226	157.5	1243	14.5
	1227	157	1244	9
	1228	156	1245	5
	1229	155	1246	2.5
	1230	154	1247	0.5
	1231	152	1248	359
	1232	150.5	1249	357.5
	1233	148	1250	356
	1234	144	1251	355.5
	1235	140	1252	354.5
	1236	133	1253	354
	1237	122	1254	354
	1238	105	1255	354
	1239Z	Ships abeam	.37 m1 radar	