

**1990 SEYMAMA, SHIVA  
MD65 CRUISE REPORT  
R/V *MARION DEFRESNE***

by

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Cruise Date: 17 August to 15 September 1990

Rice University Cruise Participants

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The following is a summary of the 1990 SEYMAMA, SHIVA, MD65 research cruise on the R/V *Marion Defresne*. SEYMAMA is an acronym for Seychelles, Madingley Rise and Maldives. The participants representing Rice University were David Mucciarone, Geoff Haddad and Oliver Aubert. On 17 August 1990, the R/V *Marion Defresne* left port in Mahé, Seychelles for a 30 day cruise that ended in Malé, Maldives on 15 September 1990.

Two thirds of the cruise was spent mainly coring the Seychelles, Madingley Rise, and Shiva with some seismic using the S-80 mostly for reconnaissance. During this portion of the cruise one Giant Piston Core (GPC) was collected in the Seychelles, five GPC on the Madingley Rise, and five GPC on the Shiva transect. The remaining one third, and the cruise objective for Rice University, was spent in the Maldives coring and shooting seismic with the S-15 and S-80 water guns. A total of sixteen GPC were collected in the Maldives along with three box cores. Unfortunately, no CTD/Niskin equipment was available to perform any hydrocasts. The whole cruise for the most part was successful, however, we did have some problems with equipment and our expectations. Although many of the equipment problems were solved without too much delay, 10 days in the Maldives was inadequate to accomplish all research objectives of Rice University and Université P. et M. Curie.

The MD65 cruise was successful in collecting 5 cores in the interior of the atolls at 364m, 494m, 525m, 778m, and 1017m and 5 cores out near ODP Site 714 at 1906m, 2284m, 2445m, 2447m, 2448m, and one core on the pinnacle at 1155m (Table 1). All of the cores were taken with the Giant Piston Coring (GPC) device that vary in length ranging from 8m to 53.6m. We collected a 53.6m GPC at ODP Site 714 approximately 2.1Ma with no apparent hiatus which set a piston coring recorded. We made several attempts to obtain an intermediate water depth core for our aragonite dissolution study (550 to 2100m) between ODP Sites 714 and 716, but were unsuccessful. One attempt was at the pinnacle in 1155m of water, about 8 to 12m of foram sand was penetrated before the core tube bent. Upon recovery the core washed and became mixed. No other cores were attempted at this location. Two other coring attempts were made just north of Fadiffolu Atoll, one in 1017m water depth which bent the core barrel after 2m of penetration in limestone. The second was taken between North Maalosmadulu and Fadiffolu in 778m of water that was successful. This core was about 35m long with an approximate age of 2.1Ma. Geoff Haddad subsampled this core for isotopes, mineralogy and organic carbon. On board the R/V *Marion Defresne*, velocity measurements were taken on this core as well as plugs for physical property analyses. This core will have to do for our intermediate water depth core for now. The other core locations are illustrated in Figure 1 and Table 1.

The seismic portion of the cruise (using the S-15) went fairly well. Twenty one lines were collected covering the area west of South Maalosmadulu Atoll, moving south between Horsburgh Atoll, Kashidoo, Rasdu Atoll, and Male Atoll (Fig. 1). The high resolution seismic data collected was good, but could have been better if a different streamer was used. The streamer on board the R/V *Marion Defresne* was 410m long with the first hydrophone 310m from the S-15 water gun (Fig. 2). The hydrophone section of the streamer contained 48 phones consisting of 8 sets of 6 phones comprising 50m. There

are two 50m hydrophone sections on the streamer. Only one streamer modification was possible. The 200m cable connected to the streamer was shortened to 50m. However, this caused the streamer to ride high in the water increasing the signal to noise ratio with increasing wave action. Ship velocity, shooting interval, water gun depth, sampling frequency, and bandwidth filtering were altered to compensate for various sea states, streamer depth and water depth in order improve the signal to noise ratio. At times the water depth was less than the streamer length.

The S-15 water gun performed as expected. Seismic data acquired with the S-15 definitely produced much better high resolution seismic data than the S-80. Unfortunately, the S-15 that was generously loaned to us by the Bureau of Mineral Resources (BMR) was at best in adequate condition. Prior to departure for the cruise Seismic System Incorporated (SSI) rebuilt/reconditioned the S-15 and reported its poor condition. SSI estimated gun repair in the field after 35,000 to 50,000 shots at best instead of the normal 150,000 shots. The S-15 required repair after each 25,000 to 28,000 shots. This poor performance was due to corrosion on the main chamber wall, piston shaft, and piston ring/seal seats. These factors drastically shortened the life of the seals. It was fortuitous that because of the streamer problems the S-15 was shot at 6 and 9 second intervals instead of 2 seconds. This allowed us to collect data over a greater area. At 2 second intervals we would not have had enough spares (3 complete sets) or time (spent making repairs) to collect half as much seismic data.

The new Elics digital acquisition system worked and traveled very well. There were no problems connecting the system to the pre amplifier, trigger device, or bandwidth filters.

In the future, Rice University should supply their own streamer and water gun unless they are sure the equipment on board ship meets their specific needs and is in excellent condition. Although these items are expensive, it would provide Rice with a complete mobile seismic system (as well as for the R/V *Lone Star*) that would greatly improve our ability to collect high resolution seismic data on any research vessel.

Only three box cores were collected in the Maldives in 1155m (pinnacle), 1905m, and 2445m (ODP Site 714) water depth. More box cores were not collected for uncertain reasons. All things considered, the box coring device on board the R/V *Marion Defresne* was not adequate for our purposes. On each of the three box cores, the sides and top were washed to an undetermined amount. All water was flushed from the box core upon reaching the deck, hence, we have no way of knowing if any pteropods were present in the surface sediments.

The following is an outline describing the overall cruise activities on a day-by-day basis beginning on 17 August and ending on 15 September 1990.

## CRUISE OUTLINE

### I. DEPART MAHE, SEYCHELLES

17 August (Day 1)	1) Cruise meeting with all scientists to discuss the overall dacruse objectives.
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2) Schedule established for 4 hr shifts for observation of 12kHz, GPS, and seismic (S-80). Oliver Aubert was assigned to this shift for the duration of cruise.

18 August  
(Day 2)

- 1) Meeting with seismic/electronic technicians about the requirements needed for the Elics digital acquisition system and the S-15 water gun (i.e., connections, voltage, pressure).
- 2) Set up S-15 water gun with float assembly, however, gun was not tested because of excessive water depth.
- 3) Elics digital acquisition system set up with 115 volt power.
- 4) 12kHz sonar working.
- 5) S-80 water gun also operational.

## II. SEYCHELLES

19 August  
(Day 3)

- 1) Shot seismic all morning with S-80 in >1500m water depth, stopped at 1200.
- 2) **Station 1**, first Giant Piston Core (GPC) attempt, problem-cable came off pulley approximate 3 hr delay no core.
- 3) **Station 2**, core on deck at 1800. Core cut into 1.5m sections, labeled, and capped by 1900 (Haddad & Mucciarone assist). Core **900936**, 24m long.
- 4) Aubert on watch (0400-0800 and 1600-2000).

## III. MADINGLEY RISE

20 August  
(Day 4)

- 1) Move from Seychelles to Madingley Rise. Arrive on station at 1300.
- 2) **Station 3**, made GPC attempt, winch broke down.
- 3) Science party meeting on core cutting procedure. Haddad and Mucciarone assigned to physical properties group and core cutting activities group (which includes washing core, cutting core into 1.5m sections, capping, carrying to rear lab for splitting, describing, labeling and loading cores in D tubes, and carrying core tubes to forward freezer for storage).

21 August  
(Day 5)

- 1) Still on station, winch not repaired-no coring.
- 2) Shot seismic with S-80 most of day stopped at 2030. Water depth >1500m.
- 3) Winch repaired by 2030, began GPC at 2245.

22 August  
(Day 6)

- 1) **Station 4**, GPC on deck at 0300. Core **900937**, 24m long, approx 1.9Ma.
- 2) **Station 5**, GPC on deck at 0300. Core **900938**, 30m long, approx 2.6 to 2.9Ma.
- 3) Haddad and Mucciarone on 6hr physical property shifts. Also assisted in core cutting activities. Aubert on watch.

4) Shot seismic with S-80 in >3000m water depth.

23 August  
(Day 7)

- 1) Physical properties (Haddad and Mucciarone) from 0200-0800.
- 2) **Station 6**, GPC on deck at 0030. Core **900939**, 5m long, 4000m WD, early trigger release.
- 3) **Station 7**, second GPC at same location, on deck at 0900, no core, GPC triggered before bottom.
- 4) **Station 8**, third GPC in same location, on deck at 1530. Core **900940** successful 30m long.
- 5) Physical properties (Haddad and Mucciarone) from 2000-0230.
- 6) **Station 9**, GPC on deck at 2100. Core **900941**, 33m long, Haddad and Mucciarone assist in core cutting activities.
- 7) Begin approx 3 day transit to SHIVA.

#### IV. SHIVA TRANSIT

24 August  
(Day 8)

- 1) Physical properties (Haddad and Mucciarone) from 1000-1400 and 2000-0200.
- 2) Finished physical properties on 900940.
- 3) Aubert still on 0400-0800 and 1600-2000 watch.

25 August  
(Day 9)

- 1) Rice cruise meeting to discuss our objectives before meeting with chief scientist Yves Lancelot. Maldives meeting with Y. Lancelot, we discussed coring (GPC & box cores), seismic (using S-15), and hydrocasts. Problem with locating a CTD/Niskin bottle array.

26 August  
(Day 10)

- 1) Shiva transit. Slow day. Rest for SHIVA stations.

27 August  
(Day 11)

- 1) Shiva transit. Slow day. Rest for SHIVA stations.

28 August  
(Day 12)

- 1) Shiva transit. Slow day. Rest for SHIVA stations.

#### V. SHIVA TRANSECT

29 August  
(Day 13)

- 1) Arrive on first Shiva station. Problems with winch again, too much weight.
- 2) **Station 10**, first Shiva GPC on deck at 0430. (Day 13) Core **900942**, 49.5m long, approx 6.0Ma in 5336m water depth. Haddad, Mucciarone and Aubert assist in core cutting activities until 0800.

- 3) Mucciarone helped water chemistry group with software problems (use of spreadsheets and graphics).
- 4) **Station 11**, second Shiva GPC on deck at 2000. Core **900943**, 45.5m long, approx 6.0Ma. Haddad and Mucciarone assist in core cutting activities until 0300.
- 5) Aubert still on watch.
- 6) A/C stopped working.

30 August  
(Day 14)

- 1) **Station 12**, third Shiva GPC on deck at 0915. Core **900944**, 44m long, approx 6.5Ma in 4850m water depth. Haddad and Mucciarone assist in core cutting activities.
- 2) **Station 13**, fourth Shiva GPC at surface at 1600-problem with early trigger. Upon retrieval of GPC, rope attached to core barrel collar used to pull core tube horizontal became tangled in propellor. Spent most of night cutting pipe to retrieve the only remaining core cutter (nose cone).
- 3) Aubert on watch (0400-0800 and 1600-2000).

31 August  
(Day 15)

- 1) **Station 14**, fifth Shiva GPC on deck at 1830. Core **900946**, 31m long, approx ?Ma in 4830m water depth. Haddad, Mucciarone and Aubert assist in core cutting activities 1830-0030.
- 2) A/C still not working.

01 September  
(Day 16)

- 1) Train Aubert how to use the Elics digital acquisition system from 0045-0215.
- 2) **Station 15**, sixth SHIVA GPC on deck at 1200. Core **900947**, 33m long, approx ?Ma in 4750m water depth. Haddad and Mucciarone assist in core cutting activities.
- 3) Begin transit to Maldives at 1330.
- 4) Cross equator at 1940 (0.00\_ N/S 75.44\_ E).

## VI. MALDIVE TRANSIT

02 September  
(Day 17)

- 1) West of Maldivé Atoll chain, seismic shot all morning with S-80 (0800-1200) as a recon for 3 GPC sites. Yves Lancelot wants 3 cores for carbonate dissolution study.
- 2) Approximately 15hrs south of Malé, Maldives.
- 3) D tube shortage, we will be unable to split all the Maldivé cores, only one or 2 cores depending on length. All other cores will be cut into 1.5m lengths, capped, taped and stored in the freezer until they reach France. Upon their arrival the cores will be split and described.
- 4) A/C still not working, lower decks getting hot.
- 5) Physical properties will be performed on the split Maldivé cores.

- 6) **Station 16**, first GPC on deck at 1900. Core **900948**, 12m long, approx ?Ma in 3954m water depth.
- 7) New shifts established to handle core cutting activities. Haddad assigned to this group and to help with physical properties.
- 8) Aubert put on 12hr watch from 2000-0800.
- 9) Mucciarone will handle seismic acquisition using Elics and S-15/S-80 water guns. Also assist Haddad with core sampling and core cutting activities when available.

03 September  
(Day 18)

- 1) **Station 17**, second GPC on deck at 0215. Core **900949**, 28m long, approx ?Ma in 3600m water depth. Haddad and Mucciarone assist in core cutting activities.
- 2) Perform physical properties on core 900949.
- 3) **Station 18**, first GPC on deck at 0800. Core **900950**, 30m long, approx 2.1Ma in 3300m water depth. Core was cut and stored only.
- 4) Line crossing party.
- 5) Short seismic into Malé (2315-0530) with S-80.

## VII. ARRIVE IN MALE

04 September  
(Day 19)

- 1) Arrive in Malé to pick up 3 Maldivian representatives, go through customs and obtain clearance to use Maldivian waters.
- 2) Depart Malé at 1330.
- 3) Set up seismic equipment (S-15, firing line, compressor line, and tow lines to water gun).
- 4) S-15 in water at 1700, begin N/S transect to ODP hole 716B.
- 5) Problems using R/V Marion Defresne streamer. The ship's streamer has 48 hydrophones in 8 groups of 6 hydrophones comprising 50m with the first hydrophone 310m to 360m from the gun. Ship speed 5kts, sampling frequency 2kHz with 2 second shooting interval. S-15 water depth 0.3m. Very high signal to noise ratio with this configuration.
  - a) Tried different ship speeds and sampling frequencies, still very noisy. Stopped seismic at 0330.
- 6) No cores were taken.
- 7) Aubert on 12hr watch and Haddad doing physical properties.

## VIII. MALDIVES

05 September

- 1) Problem with trigger on GPC, resolved by 1300

(Day 20)

by replacing the weight removed when coring in deep water in the Madingley Rise and SHIVA (not enough tension on cable).

2) **Station 19**, collected 2 cores **900951** and **900952** during trigger problem both <5m.

3) **Station 19**, first Maldive GPC on deck at 1340. Core **900953**, 33m long, approx 1.0Ma in 525m water depth.

Haddad assisted in core cutting activities. Same core location as ODP hole 716B.

4) Begin seismic at 1615 with S-80 on east transect toward ODP site 714. Recorded **Line: S80REC1** with Elics until bottom lost at 1725.

5) Begin recollecting seismic on Elics using S-80 at 1908, east/west transect of pinnacle (**Line: S80REC2**). Collect south/north transect across pinnacle at 0005 (**Line: S80REC3**).

05 September

6) Aubert on 12hr watch and Haddad working on (Day 20) cont. cores.

06 September  
(Day 21)

1) Collect south/north transect across pinnacle at 0005 (**Line: S80REC3**) end line at 0224.

2) **Station 20**, second GPC on deck at 1610. Core **900954**, 15m long, approx 1.0Ma in 1159m water depth. Haddad assisted in core cutting activities. Bent core about 15m up, core washed out/mixed during core recovery. Core consisted of foram sand. Core was not sampled, stored.

2) **Station 21**, third GPC on deck at 2200. Core **90095**, 26.2m long, approx 1.4Ma in 2284m water depth. Haddad assisted in core cutting activities. Located south of pinnacle. Core was not sampled, stored.

3) Begin seismic at 2200 with S-80 heading north from south of pinnacle looking for another intermediate water depth (approx 1000m) to take core for aragonite dissolution study.

07 September  
22)

1) Looking for intermediate water depth core site north of (Day Fadiffolu Atoll. Began collection seismic with Elics at 0915 (**Line: S80REC4**), end line at 1150.

2) **Station 22**, fourth GPC on deck at 1400. Core **900956**, 35m long, approx <2.1Ma in 778m water depth. Haddad assisted in core cutting activities. Core was sampled for isotopes, mineralogy and organic carbon by Haddad.

3) Changed float configuration on S-15 to lower the gun to 1.5 to 3.0m in water to gain better penetration, resolution and a stable signal. Y. Lancelot gave us 4hrs to work out the problems with the S-15 before taking another core. During this time we found the configurations that gave the best seismic results. The ships speed was 7kts, sampling frequency 2kHz,

shooting interval 6.0 seconds, band width of 30 to 750Hz on KrohnHite Filter, the Elics set at 20 and 800Hz. Shortened 07 September streamer cable to 150m. First hydrophone now (Day 22) cont.160 - 210m from gun.

4) **Station 23**, fifth GPC on deck at 2320. Core **900957**, 5m long, approx ?Ma in 778m water depth. Bent core barrel on limestone after about 5m of penetration. Core cut and stored.

08 September  
(Day 23)

1) Began seismic with S-15 at 0200 heading south from core 900957 between Fadiffolu Atoll and North and South Maalosmadulu Atolls to Station 24 on **Line: S15REC1 - S15REC4 (Analog Profile #15)**. End seismic at 1015 on east flank of South Maalosmadulu Atoll.

2) **Station 24**, sixth GPC on deck at 1210. Core **900958**, 36m long, approx ?Ma in 364m water depth. Core not split or sampled, stored.

3) Haddad sampling 900956, first 12 sections, Aubert still on 12hr watch.

4) Begin seismic with S-15 at 1300 on **Line: S15REC5 (Analog Profile #16)** heading east toward ODP Site 714. Stop line at 1520, switched to S-80 in deep water >1500m.

5) **Station 25**, seventh GPC on deck at 2235. Core **900959**, 32m long, approx 0.8Ma in 2447m water depth. Core not split or sampled, stored.

09 September  
(Day 24)

1) Begin seismic with S-80 to look for another coring location near ODP Site 714. End at 0500.

2) **Station 26**, eighth GPC on deck at 0830. Core **900960**, 33m long, approx 1.0Ma in 1906m water depth. Core not split or sampled, stored.

3) Move from Station 26 to begin seismic with S-15 at 1022. **Line: S15REC6A - S15REC6D** represents MLD 73-07 east to west transect between Kashidoo and Male Atoll/Horsburgh and South Maalosmadulu Atoll. **Line: S15REC7 S15REC9** are between Horsburgh and South Maalosmadulu Atoll. **Line: S15REC10** on the east flank of South Maalosmadulu Atoll and **Line: S15REC11** northwest.southeast transect between South Maalosmadulu Atoll and Male Atoll.

10 September  
(Day 25)

1) Continuing seismic with S-15 **Line: S15REC11 S15REC12**. End S-15 operation at 0309 and begin shooting with S-80 at 0435 on **Line: S80REC6A** heading northeast toward ODP Site 714 again, line will intersect Line: S15REC6A-D. **Lines: S15REC6 - S15REC12** are on **Analog Profile #18**.

2) Stop seismic at 0500 for **Station 27**, ninth GPC on deck at 1248. Core **900961**, 45m long, approx 1.2Ma in 2445m water depth. Core not split or sampled, stored.

3) Haddad finished with sampling last sections of core 900956

4) **Station 27**, first Box Core on deck at 1700. Core **AET-23**, 36cm long, in 2445m water depth. Core sampled by Haddad and Mucciarone, samples taken to Rice University.

5) **Station 28**, second Box Core on deck at 2100. Core **AET-24**, 24cm long, in 1905m water depth. Core sampled by Haddad and Mucciarone, samples taken to Rice University.

11 September  
(Day 26)

1) **Station 29**, third Box Core on deck at 0320. Core **AET-25**, 15cm long, in 1155m water depth on top of pinnacle. Core sampled by Haddad and Mucciarone, samples taken to Rice, finished at 0445.

2) Heading southwest at 0445 toward the north end of Male Atoll for seismic with S-15. Begin **Line: S15REC13 (Analog Profile #21)** at 1730 until 1930 just north of Male Atoll.

3) All seismic data from Elics system backed up on tape.

4) Rice meeting with Y. Lancelot to discuss the objectives for the remainder of the cruise. At the end of the last coring station (#31) we will have the remaining cruise time (approximately 30hrs) to shoot seismic before returning to Malé.

5) As usual Aubert on 12hr watch and Haddad assisting with core activities.

12 September  
(Day 27)

1) **Station 30**, tenth GPC on deck at 0005. Core **900962**, 25m long, approx ?Ma in 494m water depth. Haddad assisted in core cutting activities. Core not split or sampled, stored.

2) Discussed with Y. Lancelot the possibility of obtaining the analog and digital printouts of all the seismic records. No problem with this request.

3) Begin shooting seismic between Gaa Furo Reef and Horsburgh Atoll on **Lines: S15REC14 - S15REC16 (Analog Profile #22)** with S-15 at 0105. During the end of Line: S15REC16 the water gun began to leak air past the main chamber seal every 10 shots with a shooting interval of 9.0 seconds. End seismic at 1000.

4) Head directly to ODP Site 714 again for last GPC of cruise. Arrive on station at 1330.

5) Mucciarone, repair S-15 water gun for next seismic run after core. Cleaned gun and replaced all seals. Only about 28,500 shots fired on gun. Gun tested after coring at 1930.

6) **Station 31** eleventh GPC on deck at 1900. Core **900963**, **53.6m long**, approx 2.1Ma in 2448m water depth. Haddad

assisted in core cutting activities. Core not split or sampled, stored. Record breaking piston core.

13 September  
(Day 28)

1) Ready seismic equipment at 0100 (gun, streamer and Elics). Begin shooting **Line: S15REC17** at 0137. Problems with S-15 after 3.5hrs of operation. Gun failure at 0400, repaired and in operation by 0550. **Lines: S15REC17 - S15REC21** were shot between Horsburgh/Rasdu Atoll and Malé Atoll.

14 September  
(Day 29)

1) Last seismic Line: S15REC21 terminated at 0350 ending a south/north transect 2km north of ODP Site 716. **Lines: S15REC17 - S15REC21** are on **Analog Profile #23**.  
2) Begin heading to Malé at 0400.  
3) Back up all seismic lines on Elics on tape by 0415.  
4) Pack up all seismic gear, computer, samples, (Day 29) and miscellaneous equipment by 0830.  
5) Arrive in Malé at 1030.

15 September  
30)

1) Depart R/V Marion Defresne at 1100 with all scientific (Day 30) equipment and samples.

Table 1: Maldive Core Locations

Date (1990)	Core	Stn.	Lat. (N)	Long. (E)	WD (m)	Length (m)	Age (Ma)
9/02	900948	16	2_08.74	76_21.80	3954	12	?
9/03	900949	17	2_06.90	76_06.50	3697	28	?
9/03	900950	18	2_01.40	75_30.27	3269	30	<2.1
9/05	900951	19	4_56.03	73_16.04	525	5	?
9/05	900952	19	4_55.44	73_16.34	528	2	?
9/05	900953	19	4_56.15	73_16.33	525	33	1.0
9/06	900954	20	5_06.56	73_66.83	1155	8	1.0
9/06	900955	21	4_47.61	73_46.37	2284	26.2	<1.4
9/07	900956	22	5_26.41	73_11.34	778	35	<2.1
9/07	900957	23	5_28.53	73_12.95	1017	<5	?
9/08	900958	24	5_04.45	73_10.85	364	36	?
9/08	900959	25	5_03.71	73_52.60	2447	32	0.8
9/09	900960	26	5_04.84	73_47.01	1906	33	<1.4
9/10	900961	27	5_03.67	73_52.55	2445	45	<1.2
9/10	AET-23	27	5_03.70	73_52.50	2445	0.36	BC
9/10	AET-24	28	5_04.84	73_47.01	1906	0.41	BC
9/11	AET-25	29	5_06.51	73_44.81	1155	0.15	BC
9/12	900962	30	5_04.84	73_47.01	494	?	?
9/12	900963	31	5_04.84	73_47.01	53.6	53.6	<2.1

Note: BC denotes box core all others are Giant Piston Cores (GPC).

Table 2: Maldive Seismic Records Using S-15 Water Gun.

Date (1990)	Line	S.I.	Begin		End		WD (Ma)
			Lat. (N)	Long. (E)	Lat. (m)	Long. (m)	
9/08	S15REC1	6	5_ 18.31	73_ 15.98	5_ 06.38	73_ 19.42	688-516
9/08	S15REC2	6	5_ 05.92	73_ 18.76	5_ 06.08	73_ 08.40	506-313
9/08	S15REC3	6	5_ 05.72 4_ 59.57	73_ 08.01 73_ 20.77	4_ 59.57 4_ 57.81	73_ 20.77 73_ 20.11	313-519 519-519
9/08	S15REC4	6	4_ 57.53 5_ 01.91	73_ 19.68 73_ 11.08	5_ 01.91 5_ 02.82	73_ 11.08 73_ 10.69	516-388 388-375
9/09	S15REC5	6	5_ 03.89 5_ 04.18	73_ 16.28 73_ 23.47	5_ 04.18 5_ 04.13	73_ 23.47 73_ 31.13	450-518 518-1237
9/09	S15REC6A	6	4_ 55.21	73_ 37.31	4_ 55.22	73_ 32.29	2281-1881
9/09	S15REC6B	6	4_ 55.20	73_ 31.68	4_ 55.20	73_ 29.95	1650-638
9/09	S15REC6C	6	4_ 55.20	73_ 28.46	4_ 55.02	73_ 49.24	572-1016
9/09	S15REC6D	6	4_ 55.03	72_ 48.70	4_ 55.12	72_ 47.03	1200-1540
9/09	S15REC7	6	4_ 55.67	72_ 46.93	4_ 58.36	72_ 46.80	1488-1750
9/09	S15REC8A	6	4_ 58.48	72_ 50.42	4_ 58.44	72_ 53.06	450-331
9/09	S15REC8B	6	4_ 48.46	72_ 53.70	4_ 58.37	73_ 01.49	354-475
9/09	S15REC9	9	4_ 58.11	73_ 01.78	4_ 55.03	73_ 01.81	513-466
9/09	S15REC10	9	4_ 54.77	73_ 02.20	5_ 03.51	73_ 06.30	450-309
9/10	S15REC11	9	5_ 03.60	73_ 06.92	4_ 49.22	73_ 26.64	315-225
9/10	S15REC12	6	4_ 49.46	73_ 27.10	4_ 50.76	73_ 29.92	222-750
9/11	S15REC13	9	4_ 59.15 4_ 48.59	73_ 28.16 73_ 24.30	4_ 48.59 4_ 55.52	73_ 24.30 73_ 12.87	316-350 350-533
9/12	S15REC14	9	4_ 47.26	73_ 20.94	4_ 41.79	73_ 20.85	300-234
9/12	S15REC15	9	4_ 41.57 4_ 49.13	73_ 20.67 73_ 00.28	4_ 49.13 4_ 51.97	73_ 00.28 73_ 02.76	244-350 350-384
9/12	S15REC16	9	4_ 51.99	73_ 03.20	4_ 51.92	73_ 28.61	384-513

Table 2 (cont.): Maldivic Seismic Records Using S-15 Water Gun.

Date (1990)	Line	S.I.	Begin		End		WD (Ma)
			Lat. (N)	Long. (E)	Lat. (m)	Long. (m)	
9/13	S15REC17	9	4_ 40.85	73_ 20.66	4_ 37.43	73_ 19.78	247-266
			4_ 37.43	73_ 19.78	4_ 38.35	73_ 11.90	266-425
9/13	S15REC17A	9	4_ 39.12	73_ 04.22	4_ 39.82	72_ 59.89	366-303
9/13	S15REC18	9	4_ 39.60	72_ 59.78	4_ 33.23	73_ 00.22	300-261
			4_ 33.23	73_ 00.22	4_ 29.96	73_ 19.03	261-263
9/13	S15REC19	9	4_ 27.21	73_ 19.07	4_ 22.44	73_ 18.46	272-256
			4_ 22.44	73_ 18.46	4_ 22.53	73_ 03.01	256-291
9/13	S15REC20	9	4_ 22.06	73_ 02.84	4_ 13.96	73_ 02.69	288-283
			4_ 13.96	73_ 02.69	4_ 13.47	73_ 16.30	283-291
9/14	S15REC21	9	4_ 13.62	73_ 16.42	4_ 56.44	73_ 17.04	281-525