Wide-angle seismic profiling of oceanic island arc in the southern Izu-Ogasawara arc – KY0502 cruise –

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Abstract We carried out a deep wide-angle seismic experiment using a large airgun array and 110 ocean-bottom seismographs (OBSs) in the southern Izu-Ogasawara arc area. The experiment was conducted on the R/V Kaiyo of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) from 12 February to 11 March 2005 (KY05-02 cruise). Objectives of this cruise were to determine the velocity structure of the entire arc-backarc system and the difference of crustal structures formed in the Oligocene, Eocene and the present to elucidate crustal growth. An airgun-OBS seismic line was set from the Izu-Ogasawara Trench near Chichijima to the Shikoku Basin across the southern Izu-Ogasawara arc in the arc-backarc system. The OBSs and a 12-channel hydrophone streamer recorded seismic signals, which were shot using a large airgun array with total capacity of 12,000 cubic inches. In this paper, we summarize information of the seismic experiments and introduce OBS data and reflection data.

Keywords: crustal structure, seismic, wide-angle data, OBS, Izu-Ogasawara

1. Introduction

The southern Izu-Ogasawara arc-backarc system is a good example to study processes of crustal growth in oceanic island arc-backarc systems because the three parallel topographic highs, which are separated by two troughs, were formed in different ages. These highs are the Ogasawara Ridge, the present volcanic arc, and the Nishi-Shichito Ridge (Honza and Tamaki, 1985), which are located between the Izu-Ogasawara Trench and the Shikoku Basin. The two troughs are the Ogasawara Trough and the Nishinoshima Trough; the former is located between the Ogasawara Ridge and the present volcanic arc; the latter is located between the present volcanic arc and the Nishi-Shichito Ridge. The Ogasawara Ridge, which is located in the eastern side, was formed in the Eocene(e.g. Bloomer *et al.*, 1995). The Nishi-Shichito Ridge, which is located westward from the present volcanic arc, was formed in the Oligocene (e.g. Bloomer *et al.*, 1995) as an old rift zone of the northern end of the Parece Vela basin and the Sofugan tectonic line, which is located at the western wall of the Nishinoshima Trough (Yuasa, 1985).

Based on detailed mapping of magnetic anomalies and topography, the Shikoku Basin was formed from 30 to 15 Ma (Okino *et al.*, 1994). As described above, in the southern Izu-Ogasawara arc-backarc system, velocity structures might vary depending on the tectonic stage at each location. However, a few velocity structures have been determined in the southern Izu-Ogasawara arc-backarc system. We need to know the differences of crustal structures in response to these tectonic stages to understand crustal growth history.

Objectives of this research are to determine the crustal structure of the southern Izu-Ogasawara arc-backarc system and to investigate the variation of velocity structures associated with tectonic age.

2. Experiment

We carried out a wide-angle seismic survey using an airgun array and ocean bottom seismographs (OBSs) to achieve the above objectives (Fig. 1). This cruise of the R/V "Kaiyo" of Japan Agency for Marine-Earth Science and Technology (JAMSTEC) comprised two legs. The first leg was from 12 February to 25 February; the second leg was from 25 February to 11 March. The R/V Kaiyo departed from JAMSTEC on 12 February and started OBS deployment from the eastern end of the survey line on 14 February. Airgun shooting was carried out during 16 – 18 February at the eastern half of the line. After airgun shooting, we recovered 32 OBSs during 19 – 21 February. We deployed 28 OBSs again on the western part of the survey line until 22 February. The next airgun shooting was carried out until 24 February. We stopped at Port Futami of the Chichijima to change researchers on 25 February. We retrieved OBSs on the western part of the line from 26 February

1 Japan Agency for Earth-Marine Science and Technology

to 4 March. After OBS retrieval, we conducted a sea trial of a new transponder system. We left the survey area on 10 March and arrived at Shingu port on 11 March. These activities are listed in Table 1.

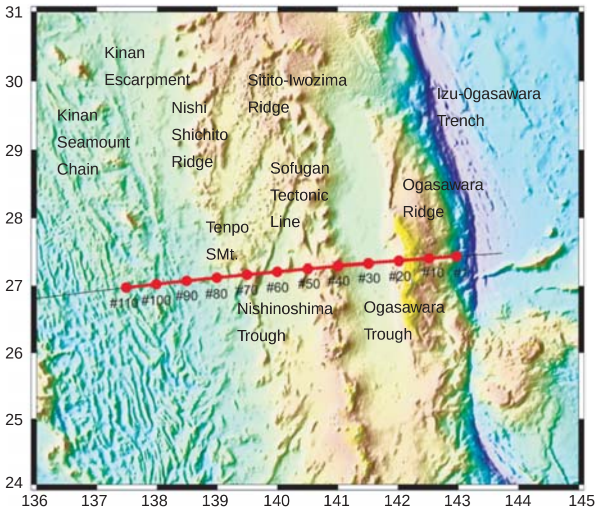

Figure 1: Map of the experimental area. Solid circles represent OBSs. We shot an airgun array on the thick black line.

To clarify the arc structure of different tectonic stage and characteristics of oceanic arc-backarc growth, we need to traverse the Eocene old arc, active volcanic arc and old arc for investigating differences of seismic structures among forearc, arc, rifted zone and backarc basins by long seismic line extension. Considering the above issues, we set the main line with length of about 600 km from near the Izu-Ogasawara Trench to the old spreading center of the Shikoku Basin. The line runs near the northern side of the Chichijima on the Ogasawara Ridge, off Nishinoshima located on the volcanic front, the Nishinoshima Trough, the Sofugan tectonic line, the Tenpo seamount, and the Shikoku Basin. The eastern and western ends of the main line (Fig. 1) were located respectively at (27°27.1598'N, 143°19.6739'E) and (26°57.1936’N, 137°16.8553’E).

For deep profiling of the entire crust, the relative powerful source and many OBSs are required to obtain the crustal image with high resolution. We used 110 OBSs and an airgun array with 12,000 cubic inch capacity. Along the line, we towed a 12-channel hydrophone

Table 1: Activity log during KY0502 cruise.

Date	Remarks
February 12	Departure from Yamashita pier of Yokohama port
February 13	Transit
February 14	OBS deployment (OBS#1-OBS#20) and emergency retrieval of OBS27
February 15	OBS deployment (OBS#27, OBS#31-OBS#72)
February 16	OBS deployment (OBS#73-OBS#81) and SPr2-1 airgun shooting
February 17	SPr2-1 airgun shooting
February 18	SPr2-1 airgun shooting
February 19	OBS retrieval (OBS#1-OBS#13)
February 20	OBS retrieval (OBS#14-OBS#27)
February 21	OBS retrieval (OBS#28-OBS#32) and OBSdeployment (OBS#82-OBS#86)
February 22	OBSdeployment (OBS#87-OBS#110) and SPr2-2 airgun shooting
February 23	SPr2-2 airgun shooting
February 24	SPr2-2 airgun shooting and transit to Futami port of Chichijima
February 25	Stopped at Futami port of Chichijima
February 26	OBS retrieval (OBS#33-OBS#43)
February 27	OBS retrieval (OBS#44-OBS#57)
February 28	OBS retrieval (OBS#58-OBS#70)
March 01	OBS retrieval (OBS#71-OBS#82)
March 02	OBS retrieval (OBS#83-OBS#93)
March 03	OBS retrieval (OBS#94-OBS#103)
March 04	OBS retrieval (OBS#104-OBS#110)
March 05	Sea trial of new transponder system
March 06	Sea trial of new transponder system
March 07	Escape for bad weather
March 08	Sea trial of new transponder system and MCS with 50 m interval gun shooting
March 09	MCS with 50 m interval gun shooting
March 10	Transit
March 11	Transit and arrival at Shingu port

streamer to determine the nature of the shallow structure attributable to severe variation of topography. The OBSs and a 12-channel hydrophone streamer recorded airgun signals.

2.1 Airgun shooting

The airgun array, with total capacity of 12,000 cubic inches, consists of eight Bolt long life airguns with 1,500 cubic inches capacity each. The air pressure sent to the chambers was 2,000 psi. The seismic experiment apparatus is shown in Fig. 2. Two floats with two airguns each were deployed respectively from port and starboard sides. The airgun array's size is 14 m length × 20 m width. The airgun's shooting position was located 135.87 m behind the ship position (respective distances from ship antenna to tail of the ship, and from tail of ship to center of the airgun array, are 29.5 m and 106.37 m). The StarFire system for seismic navigation system was used as the differential global positioning system (DGPS) of the ship navigation system. The accuracy of the shooting position was about 5 m.

2.2 Ocean Bottom Seismographs

We deployed 110 OBSs on the survey line with 5 km spacing (Fig. 1, Table 3). We recovered 109 OBSs, but one OBS was not recovered and two OBSs had no data because of recording system troubles.

All OBSs were equipped with three-component geophones (vertical and two horizontal components perpendicular to each other) using gimbal-leveling mechanisms and a hydrophone sensor. The natural frequency of these geophones was 4.5 Hz. Table 4 shows sensitivities of geophone and hydrophone sensors. Our OBSs have a digital recorder system that used a 16-bit and 20-bit A/D converter and stored data on digital audiotape or a hard disk sampling continuously with the original format (Shinohara *et al.*, 1993). The electronic power supply for the recorder system of OBS is lithium-ion batteries. The geophone sensors with a gimbal-leveling mechanism, batteries and the recorder system were installed in a 17-inch glass sphere made by Teledyne Benthos, Inc. The glass sphere was stored in a yellow hard hat. Each OBS is attached to a flashlight and a beacon with coded signals to facilitate OBS retrieval at the sea surface.

The OBSs were deployed by free fall and retrieved using an electric corrosion releaser composed of stainless steel plates connecting the OBS with a weight when

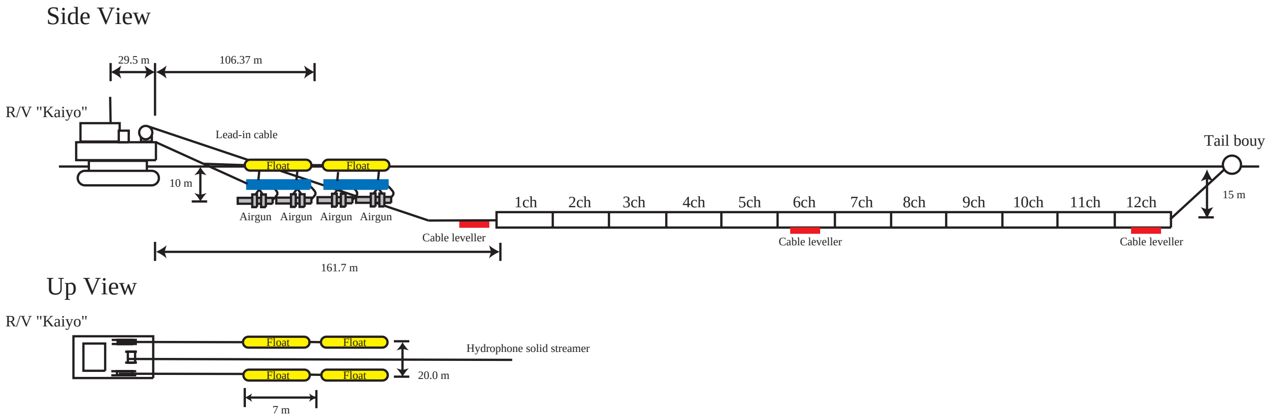

Figure 2: Geometry of the airgun system and the hydrophone streamer.

Table 2: Airgun shooting log.

SPr2-obs-1	Time (UTC)	Latitude (N)	Longitude (E)	Depth (m)	SP
First shot	2005.2.16 10:41	27° 6.8745'	138° 55.9202'	4447	2198
First good shot	2005.2.16 10:41	27° 6.8745'	138° 55.9202'	4447	2198
Last good shot	2005.2.18 20:48	27° 27.1598'	143° 19.6739'	8975	4382
Last shot	2005.2.18 20:48	27° 27.1598'	143° 19.6739'	8975	4382

SPr2-obs-2	Time (UTC)	Latitude (N)	Longitude (E)	Depth (m)	SP
First shot	2005.2.22 17:32	26° 57.1936'	137° 16.8553'	4504	1374
First good shot	2005.2.22 17:32	26° 57.1936'	137° 16.8553'	4504	1374
Last good shot	2005.2.24 15:02	27° 16.3364'	140° 45.2561'	1448	3105
Last shot	2005.2.24 15:02	27° 16.3364'	140° 45.2561'	1448	3105

Table 3: OBS information. Each recorder using DAT or hard disk is shown by each abbreviation of DAT or "HD". The "BTS" and "HIGH" respectively indicate makers of the hydrophone sensors: Teledyne Benthos Inc. and High Tech Inc.

	Deployment				Retrieval				Calibration				
Site	Time UTC	Coordinate Lat (N)	Coordinate Lon (E)	Dep (m)	Time UTC	Coordinate Lat (N)	Coordinate Lon (E)	Dep (m)	Coordinate Lat (N)	Coordinate Lon (E)	Dep (m)	HD Type	Hydrophone Type
1	2.13 22:56	27_25.8726	142_58.4260	5680	2.18 17:48	27_25.5724	142_58.4586	5653	27_25.6401	142_58.3629	5666.9	HD	BTS
2	2.13 23:31	27_25.6431	142_55.4030	4798	2.18 20:10	27_25.4918	142_55.4764	4818	27_25.4308	142_55.4450	4815.2	HD	BTS
3	2.14 0:07	27_25.4333	142_52.3808	4270	2.18 22:19	27_25.2923	142_52.3420	4205	27_25.2975	142_52.3440	4238.9	HD	BTS
4	2.14 0:44	27_25.2530	142_49.3373	3822	2.19 0:15	27_25.1330	142_49.2916	3850	27_25.1826	142_49.3128	3851.6	HD	BTS
5	2.14 1:18	27_25.0549	142_46.3122	3437	2.19 1:57	27_25.0059	142_46.2453	3435	27_24.9638	142_46.2794	3446.1	HD	BTS
6	2.14 1:51	27_24.8609	142_43.2824	3371	2.19 3:45	27_24.8897	142_43.1899	3363	27_24.7765	142_43.2644	3369.3	HD	BTS
7	2.14 2:22	27_24.6733	142_40.2561	2922	2.19 5:17	27_24.6713	142_40.1793	2908	27_24.5969	142_40.2261	2920.5	HD	BTS
8	2.14 2:56	27_24.4629	142_37.2285	2694	2.19 6:42	27_24.5259	142_37.1384	2701	27_24.4012	142_37.1927	2689.6	HD	BTS
9	2.14 3:32	27_24.2619	142_34.1904	2400	2.19 8:07	27_24.2953	142_34.1222	2419	27_24.1893	142_34.1384	2403.8	HD	BTS
10	2.14 4:05	27_24.0614	142_31.1588	2183	2.19 9:27	27_24.0477	142_31.2003	2200	27_23.9623	142_31.1814	2170	HD	BTS
11	2.14 4:40	27_23.8671	142_28.1402	1657	2.19 10:42	27_23.8253	142_28.1109	1648	27_23.7669	142_28.1114	1672.1	HD	BTS
12	2.14 5:14	27_23.6598	142_25.0986	1108	2.19 11:48	27_23.6063	142_25.1180	1125	27_23.5725	142_25.0911	1119.2	HD	BTS
13	2.14 5:50	27_23.4545	142_22.0765	806	2.19 12:51	27_23.3754	142_22.0957	813	27_23.3501	142_22.0647	828	HD	BTS
14	2.14 6:23	27_23.2508	142_19.0411	593	2.19 21:23	27_23.1378	142_19.0697	600	27_23.1484	142_19.0153	594.1	HD	BTS
15	2.14 6:56	27_23.0493	142_16.0119	234	2.19 22:10	27_22.9820	142_16.0137	235	27_22.9923	142_15.9802	239.1	HD	BTS
16	2.14 7:28	27_22.8469	142_12.9919	192	2.19 22:56	27_22.8114	142_12.8818	193	27_22.8103	142_12.9345	199.6	HD	BTS
17	2.14 8:01	27_22.6435	142_09.9506	186	2.19 23:39	27_22.6259	142_09.8993	187	27_22.6218	142_09.9128	196.7	DAT	HIGH
18	2.14 8:31	27_22.4367	142_06.9145	177	2.20 0:16	27_22.4052	142_06.8478	176	27_22.4108	142_06.8643	174.6	HD	BTS
19	2.14 9:03	27_22.2003	142_03.8912	982	2.20 1:17	27_22.1655	142_03.8280	1012	27_22.1575	142_03.8196	999.7	HD	BTS
20	2.14 9:37	27_21.9970	142_00.8698	2258	2.20 2:37	27_22.0663	142_00.6451	2280	27_21.9769	142_00.7503	2264.4	HD	HIGH
21	2.14 10:11	27_21.7866	141_57.8436	2772	2.20 4:11	27_21.8478	141_57.7242	2791	27_21.7314	141_57.7165	2817.1	HD	BTS
22	2.14 10:38	27_21.5491	141_54.7885	3129	2.20 5:49	27_21.5813	141_54.8158	3123	27_21.5153	141_54.7807	3120.9	HD	HIGH
23	2.14 11:07	27_21.3400	141_51.7578	3245	2.20 7:26	27_21.4137	141_51.7317	3250	27_21.3328	141_51.6471	3266.8	HD	BTS
24	2.14 11:36	27_21.1175	141_48.7409	3749	2.20 9:04	27_21.2620	141_48.7861	3744	27_21.0692	141_48.6580	3730.8	HD	HIGH
25	2.14 12:05	27_20.9078	141_45.7146	4007	2.20 10:57	27_21.0462	141_45.7663	4010	27_20.8674	141_45.6322	4028.4	HD	BTS
26	2.14 12:35	27_20.6871	141_42.6968	4055	2.20 12:55	27_20.8267	141_42.7888	4051	27_20.7167	141_42.6224	4054.6	HD	BTS
27	2.14 16:16	27_20.4741	141_39.6998	4068	2.20 14:54	27_20.5956	141_39.7649	4070	27_20.4987	141_39.6609	4065.8	HD	BTS
28	2.14 13:35	27_20.2533	141_36.6322	4071	2.20 16:51	27_20.3174	141_36.7221	4075	27_20.2593	141_36.6302	4062.2	HD	BTS
29	2.14 14:06	27_20.0235	141_33.6099	4068	2.20 18:36	27_20.0638	141_33.6893	4072	27_20.0200	141_33.6008	4048.3	HD	BTS
30	2.14 14:35	27_19.7799	141_30.5705	4062	2.20 20:48	27_19.7628	141_30.7222	4068	27_19.8208	141_30.6187	4074.5	DAT	BTS
31	2.14 17:37	27_19.5863	141_27.5523	4057	2.20 22:51	27_19.5909	141_27.7088	4047	27_19.6087	141_27.6000	4054.8	HD	BTS
32	2.14 18:08	27_19.3594	141_24.5146	4017	2.21 0:52	27_19.3078	141_24.7237	4025	27_19.3610	141_24.6103	4024.2	HD	BTS
33	2.14 18:39	27_19.1352	141_21.4861	3972	2.25 21:21	27_19.0500	141_21.5765	3965	27_19.0873	141_21.6656	3956.3	HD	BTS
34	2.14 19:12	27_18.9170	141_18.4722	3874	2.25 23:20	27_18.7587	141_18.5561	3874	27_18.7944	141_18.5389	3884.5	HD	BTS
35	2.14 19:44	27_18.6754	141_15.4322	3697	2.26 1:07	27_18.5674	141_15.5269	3700	27_18.6043	141_15.4317	3697.6	HD	HIGH
36	2.14 20:18	27_18.4542	141_12.4169	3532	2.26 2:54	27_18.3770	141_12.5348	3533	27_18.4143	141_12.3885	3524.7	HD	BTS
37	2.14 20:51	27_18.2186	141_09.4055	3307	2.26 4:51	27_18.2249	141_09.4488	3312	27_18.2786	141_09.3283	3327.5	HD	BTS
38	2.14 21:25	27_17.9911	141_06.3933	3033	2.26 6:31	27_17.8168	141_06.4221	3040	27_17.8614	141_06.4173	3040.4	HD	BTS
39	2.14 22:00	27_17.7549	141_03.3549	—	2.26 8:08	27_17.5486	141_03.2868	2663	27_17.5860	141_03.3450	2688.2	HD	HIGH
40	2.14 22:31	27_17.5181	141_00.3399	2247	2.26 9:32	27_17.4529	141_00.2719	—	27_17.4798	141_00.3174	2247.3	HD	BTS
41	2.14 23:03	27_17.2906	140_57.3375	1730	2.26 10:47	27_17.3216	140_57.3501	1736	27_17.2719	140_57.3312	1729	HD	BTS
42	2.14 23:35	27_17.0477	140_54.2986	1046	2.26 11:55	27_17.1014	140_54.4071	1074	27_17.0489	140_54.3363	1053.6	HD	HIGH
43	2.15 0:09	27_16.8140	140_51.2705	816	2.26 13:01	27_16.8727	140_51.4537	746	27_16.8422	140_51.2723	816.4	HD	HIGH
44	2.15 0:41	27_16.5777	140_48.2470	1437	2.26 14:21	27_16.6392	140_48.3399	1421	27_16.6010	140_48.2422	1439	HD	BTS
45	2.15 1:13	27_16.3369	140_45.2214	1453	2.26 15:36	27_16.3666	140_45.2319	1440	27_16.3653	140_45.2422	1442.4	DAT	BTS
46	2.15 1:45	27_16.1002	140_42.1986	1301	2.26 16:54	27_16.0992	140_42.1308	1258	27_16.1448	140_42.1817	1327.7	HD	BTS
47	2.15 2:16	27_15.8611	140_39.1734	1893	2.26 19:06	27_15.6519	140_38.0608	2017	27_15.8822	140_39.1975	1878.9	HD	HIGH
48	2.15 2:46	27_15.6158	140_36.1496	2120					27_15.6673	140_36.1102	2119	HD	BTS
49	2.15 3:16	27_15.3726	140_33.1221	2154	2.26 23:43	27_15.3936	140_33.1548	2169	27_15.3810	140_33.0909	2164.9	HD	HIGH
50	2.15 3:48	27_15.1411	140.30.1041	1504	2.27 1:00	27_15.2217	140_30.1703	1550	27_15.1717	140_30.0773	1535.5	HD	BTS
51	2.15 4:20	27_14.8723	140_27.0237	2655	2.27 2:34	27_14.9020	140_27.1526	2607	27_14.8618	140_26.9851	2640.7	HD	BTS
52	2.15 4:50	27_14.6104	140_24.0499	3361	2.27 4:23	27_14.5965	140_24.2090	3322	27_14.5932	140_23.9946	3338.5	HD	BTS
53	2.15 5:20	27_14.3565	140_21.0259	3477	2.27 6:15	27_14.2499	140_21.0487	—	27_14.3268	140_20.9871	3500.5	HD	BTS
54	2.15 5:49	27_14.1280	140_18.0059	3499	2.27 8:04	27_13.9924	140_17.9280	3507	27_14.0908	140_17.9588	3496.7	HD	BTS
55	2.15 6:18	27_13.8729	140_14.9866	3497	2.27 9:47	27_13.7107	140_14.9319	—	27_13.7985	140_14.9683	3510.1	HD	BTS
56	2.15 6:46	27_13.6271	140_11.9660	3203	2.27 11:25	27_13.5008	140_11.9320	—	27_13.5768	140_11.9025	3217.2	HD	BTS
57	2.15 7:16	27_13.3847	140_09.9380	3305	2.27 13:00	27_13.3143	140_08.9937	3329	27_13.2966	140_08.8801	3304.8	HD	HIGH
58	2.15 7:45	27_13.1357	140_05.9244	3605	2.27 14:41	27_13.0012	140_06.1660	3566	27_12.9559	140_06.0093	3624.7	HD	HIGH
59	2.15 8:14	27_12.8839	140_03.9061	3543	2.27 16:31	27_12.9174	140_03.0653	3477	27_12.8406	140_02.9045	3531.9	HD	BTS
60	2.15 8:43	27_12.6128	139_59.8873	3778	2.27 18:24	27_12.5999	140_00.0033	3774	27_12.5466	139_59.8688	3786.7	HD	BTS
61	2.15 9:11	27_12.3620	139_56.8773	3780	2.27 20:20	27_12.2468	139_56.9297	3806	27_12.2853	139_56.8682	3784.4	DAT	HIGH
62	2.15 9:40	27_12.1101	139_53.8556	3826	2.27 22:13	27_12.1020	139_53.8059	3818	27_12.1463	139_53.7973	3824.2	HD	BTS
63	2.15 10:10	27_11.8368	139_50.8336	3825	2.28 0:04	27_11.7540	139_50.9457	3825	27_11.7617	139_50.9321	3831.6	HD	HIGH

Table 3: (Continued).

Site	Deployment				Retrieval				Calibration			HD Type	Hydrophone Type
	Time UTC	Coordinate Lat (N)	Coordinate Lon (E)	Dep (m)	Time UTC	Coordinate Lat (N)	Coordinate Lon (E)	Dep (m)	Coordinate Lat (N)	Coordinate Lon (E)	Dep (m)		
64	2.15 10:41	27_11.5836	139_47.8171	3804	2.28 1:53	27_11.5456	139_47.9183	3800	27_11.5190	139_47.8128	3799.6	HD	BTS
65	2.15 11:10	27_11.3220	139_44.7975	3280	2.28 3:39	27_11.2013	139_44.9172	3368	27_11.1745	139_44.7815	3325	HD	HIGH
66	2.15 11:40	27_11.0578	139_41.7790	2544	2.28 5:14	27_10.9762	139_41.9169	—	27_10.9797	139_41.8388	2550.3	HD	BTS
67	2.15 12:08	27_10.7968	139_38.7526	1197	2.28 6:25	27_10.7862	139_38.8149	1180	27_10.7535	139_38.8028	1208	HD	BTS
68	2.15 12:39	27_10.5334	139_35.7438	1419	2.28 7:37	27_10.5233	139_35.8033	1410	27_10.5210	139_35.7909	1413.7	HD	BTS
69	2.15 13:09	27_10.2645	139_32.7208	2855	2.28 9:12	27_10.2709	139_32.6990	2795	27_10.2235	139_32.7063	2855.2	HD	BTS
70	2.15 13:39	27_10.0053	139_29.7034	3356	2.28 10:56	27_09.9849	139_29.6510	3365	27_09.9694	139_29.6725	3362.6	HD	BTS
71	2.15 14:10	27_09.7347	139_26.6876	2952	2.28 12:26	27_09.6982	139_26.6462	—	27_09.6721	139_26.6543	2939.9	HD	BTS
72	2.15 14:39	27_09.4590	139_23.6722	2933	2.28 13:53	27_09.4367	139_23.7338	2890	27_09.3934	139_23.7100	2903.6	HD	BTS
73	2.15 15:10	27_09.1999	139_20.6474	3206	3. 1 0:38	27_09.1549	139_20.7075	—	27_09.1233	139_20.7222	3193.1	HD	BTS
74	2.15 15:40	27_08.9293	139_18.6336	3426	3. 1 2:24	27_08.8952	139_17.7972	3421	27_08.9108	139_17.6675	3428.8	HD	BTS
75	2.15 16:12	27_08.6606	139_15.6128	4162	3. 1 4:16	27_08.6538	139_14.7839	4121	27_08.6885	139_14.6311	4153.6	DAT	BTS
76	2.15 16:43	27_08.3873	139_11.6036	3919	3. 1 6:05	27_08.2432	139_11.7079	3920	27_08.3873	139_11.6393	3895.6	HD	HIGH
77	2.15 17:13	27_08.1073	139_08.5810	4060	3. 1 7:59	27_07.9569	139_08.6473	4084	27_08.1198	139_08.6221	4070.1	HD	BTS
78	2.15 17:42	27_07.8388	139_05.5633	4215	3. 1 9:52	27_07.7063	139_05.6515	—	27_07.8577	139_05.5928	4207.3	HD	BTS
79	2.15 18:11	27_07.5593	139_02.5582	4252	3. 1 11:50	27_07.4504	139_02.6304	—	27_07.5698	139_02.5853	4257.8	HD	BTS
80	2.15 18:42	27_07.2778	138_59.5376	4366	3. 1 13:46	27_07.2136	138_59.6606	4369	27_07.2603	138_59.5521	4369.5	HD	BTS
81	2.15 19:11	27_06.9996	138_56.5156	4433	3. 1 15:41	27_06.9452	138_56.6925	4448	27_06.9509	138_56.5516	4438.6	HD	BTS
82	2.21 12:37	27_06.7162	138_53.5138	4405	3. 1 17:46	27_06.6818	138_53.6493	—	27_06.7002	138_53.5354	4409.5	HD	BTS
83	2.21 13:13	27_06.4371	138_50.4949	4365	3. 1 20:08	27_06.3623	138_50.5526	—	27_06.3953	138_50.4476	4352.4	HD	BTS
84	2.21 13:44	27_06.1662	138_47.4883	3981	3. 1 22:19	27_06.0884	138_47.4310	3935	27_06.1273	138_47.4520	3994	HD	BTS
85	2.21 14:14	27_05.8876	138_44.4676	3613	3. 2 0:02	27_05.8573	138_44.4815	3500	27_05.9102	138_44.4743	3533.2	HD	BTS
86	2.21 14:46	27_05.5975	138_41.4487	4560	3. 2 2:02	27_05.6662	138_41.4565	4572	27_05.5916	138_41.4361	4550.9	HD	BTS
87	2.21 15:20	27_05.3077	138_38.4402	4739	3. 2 4:05	27_05.3708	138_38.4748	4732	27_05.2924	138_38.4352	4733.3	HD	BTS
88	2.21 15:51	27_05.0294	138_35.4244	4802	3. 2 6:04	27_05.1100	138_35.4554	4799	27_05.0097	138_35.3641	4796.9	DAT	BTS
89	2.21 16:22	27_04.7447	138_32.4126	4899	3. 2 8:19	27_04.7551	138_32.4607	—	27_04.7627	138_32.3922	4900.8	HD	BTS
90	2.21 16:53	27_04.4551	138_29.3963	4834	3. 2 10:27	27_04.4202	138_29.4061	4834	27_04.4942	138_29.4058	4835.8	HD	BTS
91	2.21 17:23	27_04.1631	138_26.3801	4914	3. 2 12:35	27_04.1006	138_26.3256	4918	27_04.1618	138_26.3021	4909.8	HD	BTS
92	2.21 17:53	27_03.8739	138_23.3721	4551	3. 2 14:47	27_03.9099	138_23.3951	4643	27_03.8989	138_23.3615	4632.2	HD	BTS
93	2.21 18:22	27_03.5832	138_20.3459	4824	3. 2 17:27	27_03.6594	138_20.3624	4791	27_03.5722	138_20.2588	4815.7	HD	BTS
94	2.21 18:51	27_03.2952	138_17.3450	5013	3. 2 19:46	27_03.3351	138_17.3384	5027	27_03.2379	138_17.2516	5004.1	HD	HIGH
95	2.21 19:21	27_02.9993	138_14.3266	4586	3. 2 22:02	27_02.9629	138_14.2603	4584	27_02.9243	138_14.3700	4583.6	HD	BTS
96	2.21 19:49	27_02.7138	138_11.3346	4878	3. 3 0:22	27_02.6490	138_11.2604	4810	27_02.6174	138_11.2719	4858.6	HD	BTS
97	2.21 20:18	27_02.4098	138_08.3094	4559	3. 3 2:22	27_02.3211	138_08.2339	4544	27_02.2823	138_08.2101	4536.3	HD	BTS
98	2.21 20:47	27_02.1199	138_05.3027	5081	3. 4 9:30	27_01.9743	138_05.4378	5080	27_02.0437	138_05.3346	5077.6	HD	BTS
99	2.21 21:17	27_01.8174	138_02.2966	5006	3. 4 11:40	27_01.6826	138_02.3546	4980	27_01.6655	138_02.2281	4989.2	DAT	BTS
100	2.21 21:46	27_01.5170	137_59.2831	4948	3. 4 13:52	27_01.3808	137_59.3374	—	27_01.3957	137_59.2048	4944.8	HD	BTS
101	2.21 22:15	27_01.2221	137_56.2823	4713	3. 4 16:05	27_01.0295	137_56.2659	4689	27_01.1032	137_56.1972	4754.4	HD	BTS
102	2.21 22:43	27_00.9273	137_53.2698	4648	3. 4 18:14	27_00.7801	137_53.2988	4729	27_00.8011	137_53.2196	4686.9	HD	BTS
103	2.21 23:10	27_00.6151	137_50.2533	4930	3. 4 20:25	27_00.4631	137_50.2904	4924	27_00.4959	137_50.2157	4919.1	HD	BTS
104	2.21 23:37	27_00.3095	137_47.2414	4853	3. 4 22:30	27_00.0885	137_47.2693	4850	27_00.1809	137_47.2417	4846.4	HD	BTS
105	2.22 0:05	27_00.0104	137_44.2294	4608	3. 5 0:28	26_59.7737	137_44.2521	—	26_59.8877	137_44.1975	4601.2	HD	BTS
106	2.22 0:32	26_59.6990	137_41.2239	4421	3. 5 1:05	26_59.4385	137_41.1690	4460	26_59.5686	137_41.1462	4426	HD	BTS
107	2.22 0:59	26_59.4020	137_38.2236	5215	3. 5 3:16	26_59.1321	137_38.1167	5232	26_59.3124	137_38.1418	5220.9	HD	BTS
108	2.22 1:25	26_59.1008	137_35.2075	5160	3. 5 4:03	26_58.8705	137_35.1483	5210	26_59.0173	137_35.1652	5171.8	HD	BTS
109	2.22 1:51	26_58.7937	137_32.2023	4676	3. 5 6:10	26_58.5813	137_32.0796	4689	26_58.7743	137_32.1536	4701.1	HD	BTS
110	2.22 2:18	26_58.4736	137_29.2071	4426	3. 5 6:52	26_58.3487	137_29.1420	4423	26_58.4154	137_29.0912	4407.8	HD	BTS

Table 4: Sensitivities of geophone and hydrophone sensors.

Sensor type	Sensor name	Maker	Sensitivity	Sensitivity	Frequency
Geophone (three components)	L-28LB.H.V	Mark Products	0.69 V/in/sec	0.69 V/in/sec	4.5Hz (natural freq.)
Hydrophone	AQ-18	Benthos, inc.	-169 dB	-169 dB	1Hz - 12kHz
Hydrophone	HTI-99DY	HIGH TECH, inc	-165dB	-165dB	2Hz - 20kHz

a transponder system receives an acoustic signal sent from a vessel. This acoustic communication between the OBS and the vessel was performed using transducers installed on the vessel. Positions of OBSs on the sea bottom are estimated by SSBL of the vessel's positioning system during the cruise.

After the cruise, we edited continuous OBS data to lengths of 70 s and SEG-Y format. Simultaneously, calibration of the OBS clock for GPS time was carried out using differences between OBS clock time and GPS time, which were measured immediately before OBS deployment and immediately after OBS retrieval.

2.3 Multichannel hydrophone streamer

During airgun shooting, we towed a 12-channel hydrophone streamer to probe the shallow structure, in particular, a distribution of sediments with low P-wave velocity (Fig. 2). The hydrophone streamer cable was a Stealtharray ST-48 made by Sercel Inc. The interval of each channel was 25 m. The respective lengths of active section and read-in cable until the ship end were 300 m and 150 m. Hydrophone sensors (free-field 1/2 microphone; Brüel & Kjaer) with sensitivity of -25.9 dB re1V/Pa (50.4 mV/Pa) were used. Analog signals from five sensors in same channel were stacked before A/D conversion. The A/D conversion kit was attached in the recording system, the StrataVisor NX Marine made by Geometrics Inc.; digitized data were recorded on DLT tapes with SEG-D format. No recording delay was set. The sampling rate was 4 ms and the record length was 13.5 s. Seismic records from the eighth channel were not good during this cruise. For that reason, we omitted the traces.

2.4 Seismic recording/shooting system

The seismic system of R/V "Kaiyo" consists of a navigation system with SPECTRA software, a recording system (StrataVisor NX Marine; Geometrics Inc.) and a gun controller system (GCS90). Those systems are connected via RTN. As mentioned above, we adapted Starfire as a seismic system navigation source. Navigation data collected from Starfire and Skyfix for the ship's navigation system were sent to the RTNμ via the terminal server connecting the LAN of the ship and this MCS system. The RTNμ obtains time signals of GPS (Starfire) from the original antenna. Then, the navigation data are sent to the PC Linux machine with installed SPECTRA software and monitored on the display. Timing of the system start, shot number, and so on, are set on the SPECTRA software. The system start signal generated from SPECTRA was sent to the gun controller and the recording system as a trigger signal via the RTNμ. The gun controller sent back the internal time break signal to the master clock and RTNμ immediately after getting trigger signals. The trigger signals were sent to eight airguns as shot signals, and the recording system started to record seismic data from a hydrophone streamer. The first break signal was sent to the gun controller from the airguns at same timing with the shot. Then the gun controller sent the shot data to RTNμ.

3. Data

In this chapter, we introduce examples of the seismic data obtained by OBSs deployed on the Ogasawara Ridge (OBS#6), the Nishinoshima Trough (OBS#63) and the Shikoku Basin (OBS#91). Vertical components of OBS#6, OBS#63 and OBS#91 and horizontal components of OBS#6 and OBS#91 are described in section 3.1.

3.1 OBS

The data quality of available OBSs is good. We can trace the first phases on vertical records to 200 km distance from each OBS. Horizontal records also show good quality despite a poorer S/N ratio than the vertical. We describe characteristics of OBS data using vertical record sections of OBS#6 (Fig. 3), OBS#63 (Fig. 4) and OBS#91 (Fig. 5) as follows. These records suggested a thick crust in the Ogasawara Trough and a thin crust in the Shikoku Basin. In the Nishinoshima Trough and the western slope of Nishi-shichito Ridge, the crusts might be thicker than typical oceanic crust.

The OBS#6 was deployed on the eastern slope of the Ogasawara Ridge. We can trace first arrivals up to an offset of 170 km from the OBS in the western side (Fig. 3). The apparent velocities of the first arrival phases are 4.3 km/s at 5 – 30 km offsets in the eastern side. In the western side, apparent velocities of first arrivals are about 6.2 km/s at 4 – 14 km offsets, 8.4 km/s at 14 – 22 km, about 10 km/s at 22 – 38 km, 6.0 km/s at 68 – 74 km, 7.3 km/s at 100 – 115 km, 7.2 km/s at 120 – 130 km and 8.2 km/s at 140 – 150 km. Variations of these apparent velocities are caused by a rough topography of some ridges and troughs. Reflections from the Moho (PmP) with high amplitudes are apparent around an offset of 120 km. The Pn can trace over the offset of 160 km. In the horizontal record, large P wave conversion phases prevent observation of clear S arrivals. The S-wave apparent velocity is about 2.9 km/s at 6 – 16 km distance at the western side of OBS (Fig. 3).

The OBS#63 was deployed on the Nishinoshima Trough. We can trace first arrivals up to an offset of

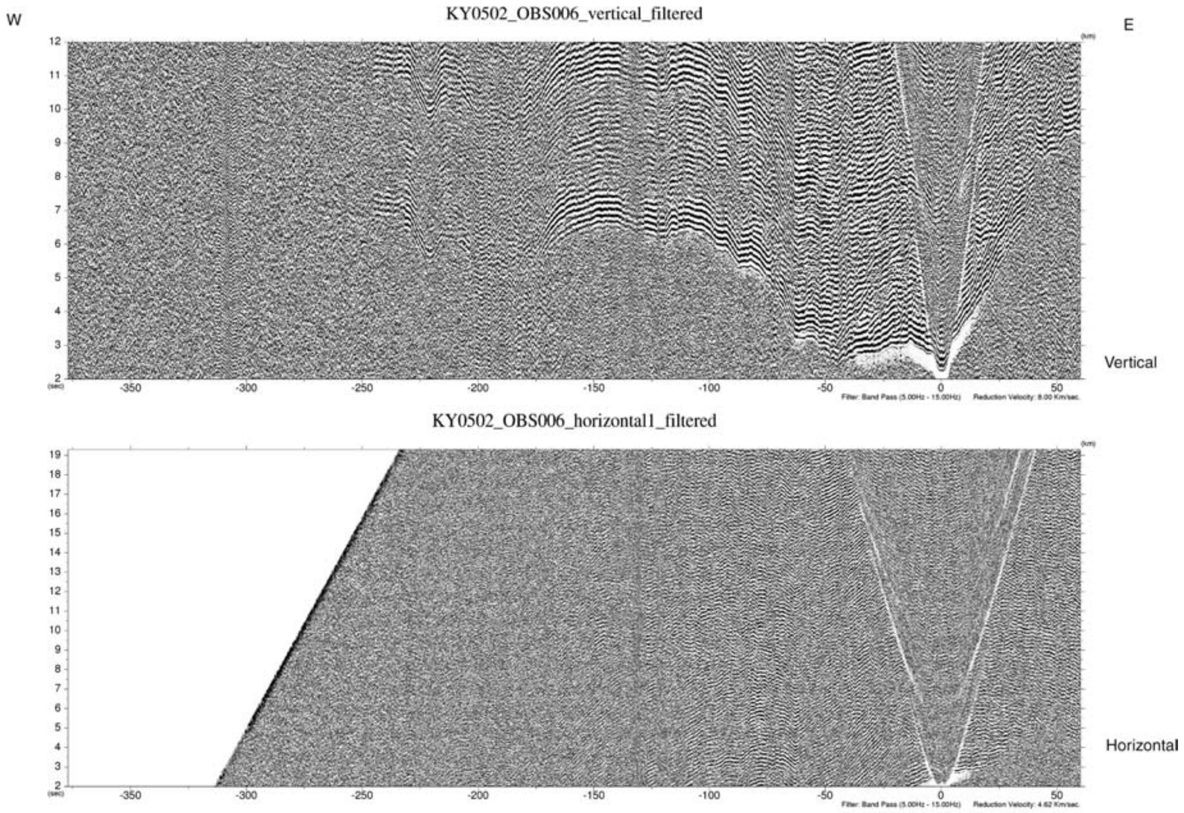

Figure 3: Vertical and horizontal record section recorded by OBS#6. All traces are filtered using 5 – 15 Hz. Vertical and horizontal axes are offsets from OBS. The vertical section shows travel times reduced by 8 km/s. The horizontal section shows travel times reduced by 4.62 km/s.

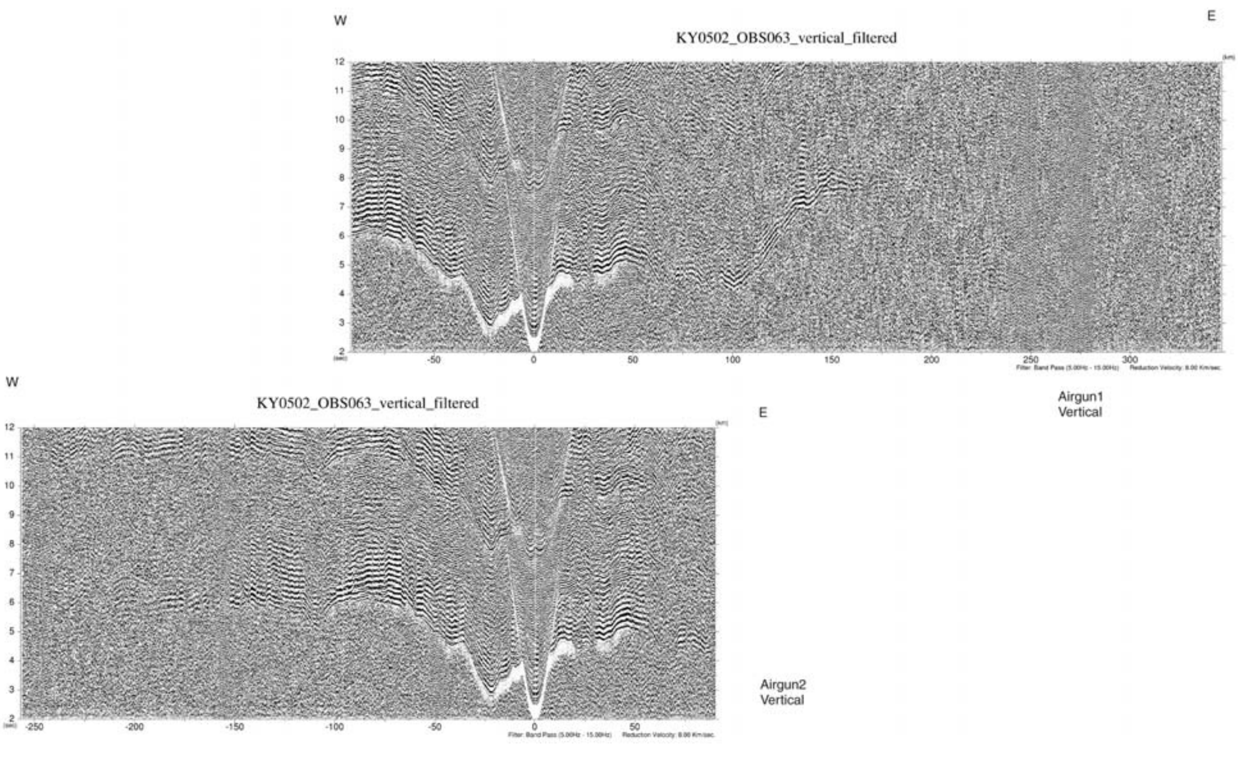

Figure 4: Vertical record sections of two overlapped airgun shootings recorded by OBS#63. The details are same as for Fig. 4.

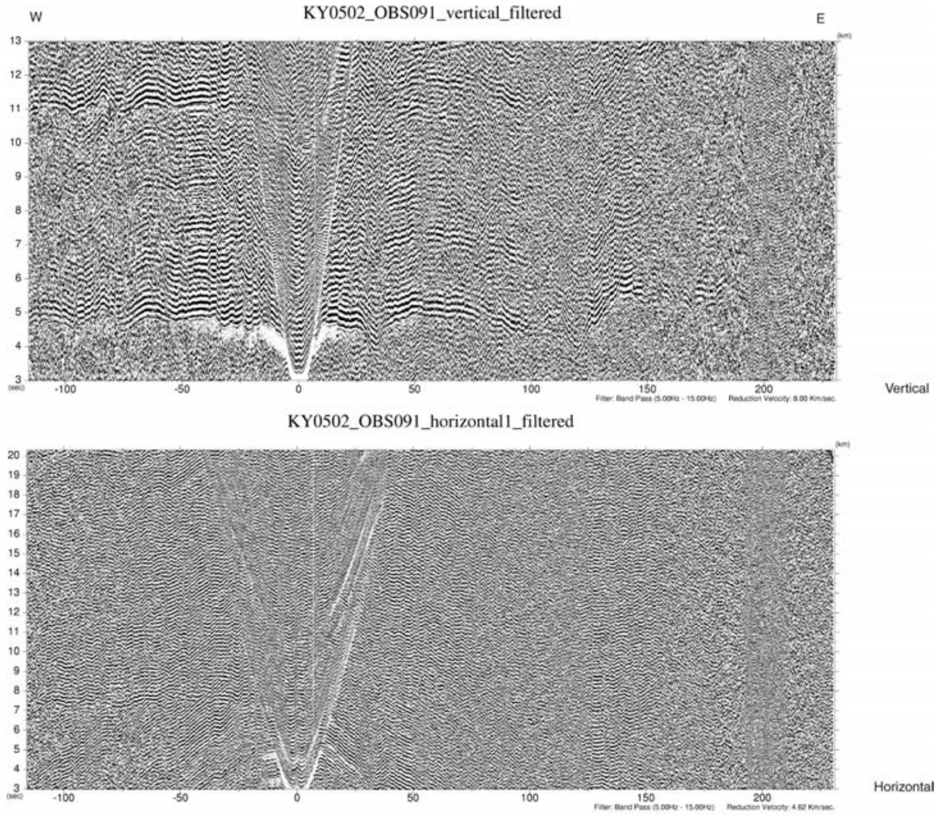

Figure 5: Vertical and horizontal record section recorded by OBS#91. The details are identical to those for Fig. 3.

170 km from the OBS in the eastern side and 240 km offset in the western side (Fig. 4). The apparent velocities of the first arrival phases at the eastern side are 4.5 km/s at 3 – 13 km offsets, 7.8 km/s at 30 – 37 km offsets and 5.0 km/s at 100 – 130 km offset. The PmP with high amplitudes are also apparent around an offset of 120 km. The Pn can trace around the offset of 140 km. In the western side, apparent velocities of first arrivals are more over 10 km/s at 13 – 21 km offsets, 3.9 km/s at 22 – 35 km offsets, 5.3 km/s at 44 – 60 km, 7.1 km/s at 68 – 82 km, 8.9 km/s at 82 – 100 km and 8.0 km/s at 120 – 145 km. The first arrivals are apparent down convex at offset 22 km, 42 km and 110 km because of the topographic high. PmP with high amplitudes are also apparent around an offset of 90 km. The Pn can be traced over the offset of 200 km.

The OBS#91 was deployed on the Shikoku Basin near the southern elongation of the Kinan escarpment. In the eastern side, apparent velocities of first arrivals are 3.8 km/s, 8.5 km/s and 8.0 km/s at offsets of 8 – 12 km, 12 – 25 km and 38 – 75 km (Fig. 5). Because of the topographic high, these phases are apparent down convex at offsets of 33 km, 100 km and 120 km. On the western side, apparent velocities of first arrivals are 5.6 km/s and 8.0 km/s, respectively, in offsets of 5 – 17 km and 37 – 55 km. These arrivals are apparent down convex at offsets of 22 km, 33 km, 75 km and 97 km. These variations of phases are caused by rough topography of the old spreading center of the Shikoku Basin. In the horizontal record, apparent velocities are 3.8 km/s at the 22 – 27 km distance of the eastern side of OBS and 4.5 km/s at the 17 – 43 km distance of the western side of OBS (Fig. 5).

3.2 MCS

Reflection data recorded by the 12-channel hydrophone streamer have sufficient quality to pick the acoustic basement (Fig. 6). Data processing was a collection of spherical divergence, editing bad quality traces, deconvolution, an NMO correction with water velocity of 1500 m/s, tacking, a time variant band pass filter of 20 – 60 Hz, time migration, and auto gain control. Because of the channel interval of 25 m and the shot interval of 200 m, the fold number was 1 or 2.

We next describe rough characteristics of reflection images. In the upper part of the forearc slope, thick sediments cover the rough basement. A steep slope and normal faults characterize the eastern wall of the Ogasawara Trough. In contrast, the western wall of the trough is covered with thick sediments, which might be supplied from the present volcanic front. A thick sediment and a rough acoustic basement characterize the

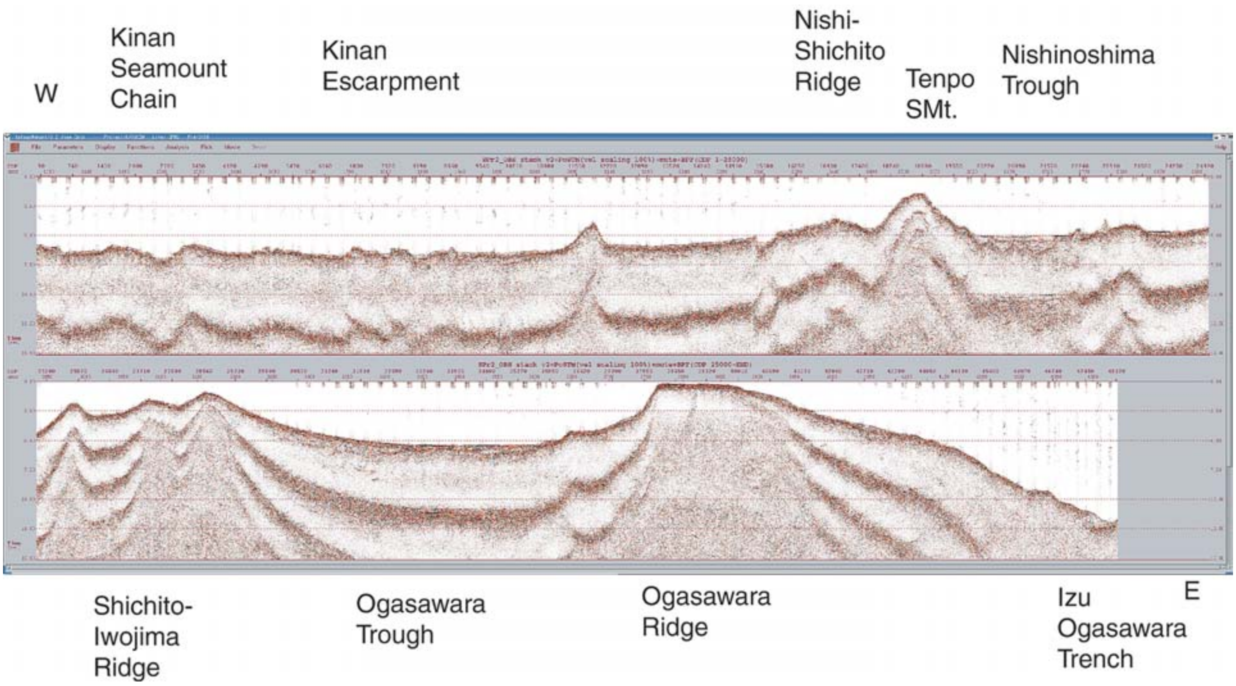

Figure 6: MCS profile of KY0502 cruise. The 12ch hydrophone streamer and 12000 cubic inch airgun were used.

Nishinoshima Trough. It is divided into two parts by the basement high. The eastern part of the trough is covered with the sediment, which might be supplied from both sides of the slope. On the other hand, isopachous sedimentary layers characterize the western part of the trough because volcanic sediments from the present volcanic arc are trapped at the eastern side of this trough by a basement high. From the western slope of the Nishi-Shichito Ridge to the extension of the Kinan escarpment, several saw-tooth concavities are distributed. A sharp western wall and westward thickening sediments in each saw tooth characterize them. From the extension of the Kinan escarpment to the extension of Kinan seamount chain, thin sediment covers the basement.

4. Summary

This paper summarized the specifications and arrangements of seismic experiments carried out in the southern Izu-Ogasawara arc area and introduced seismic data. Because of the good data quality of the OBSs, we were able to trace the first P-arrivals to the offsets of 100 km from each OBS. We will investigate the velocity structural variation across the arc-backarc system and general oceanic arc to clarify the oceanic arc growth at different tectonic stages.

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Second Officer	Yasuo Deai
Second Officer	Akihisa Tsuji
Third Officer	Yoshiki Kon
Chief Engineer	Hiroyuki Shibata
First Engineer	Masahiro Kajiwara
Second Engineer	Chikara Onohara
Third Engineer	Naohiro Tatooka

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Second Radio Officer	Kiyotaka Yamashita
Third Radio Officer	Yusuke Takeuchi
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Able seaman	Yoshihiro Kinoshita
Able seaman	Kengo Fujino
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