Wide-angle seismic experiment crossing the Sofu-gan tectonic line in the Izu-Ogasawara arc – KY0507 cruise –

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Abstract We conducted a wide-angle seismic experiment using a large volume (200l) airgun array and 110 ocean bottom seismographs (OBSs) in the central and southern Izu-Ogasawara region. The experiment was KY05-07 cruise using R/V Kaiyo of Japan Agency for Marine-Earth Science and Technology (JAMSTEC) during July 8 and August 1, 2005. Objectives of the experiment are to reveal a velocity structure of the central and southern Izu-Ogasawara region, and to constrain the structural variation along the profile, especially crossing the Sofu-gan tectonic line. The total shot number of the large volume airgun array was 7300, which were recorded by the OBSs and a 12-ch hydrophone streamer towing simultaneously. In this paper, we summarize information of the experiments and introduce OBS and streamer data.

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

1. Introduction

An oceanic island arc is one of the best examples to study a process of the crustal growth, because the crustal growth had been started by a subduction of an oceanic crust beneath the other oceanic crust and the tectonic history is simpler than that of a continental arc, which had been separated from the continental margin with complex structure. The oceanic arc is one of products formed by 'subduction factory'[1)].

The Izu-Ogasawara arc is a typical oceanic island arc and has formed by the subduction of the Pacific Plate beneath the Philippine Sea Plate since Eocene time[2)]. Recently, the wide-angle refraction and reflection experiment was conducted in the northern Izu-Ogasawara arc transect, so that the layer with 6-km/s of P-wave velocity is found and interpreted as the granitic middle crust[3)4)]. However, there is bathymetric variation along the Izu-Ogasawara arc: bathymetric high as islands and seamounts, and bathymetric low as deep region between the seamounts. The volume of volcanic material also varies along the northern arc[5)]. These results indicate that the igneous activity in the Izu-Ogasawara arc is not occurred homogeneously in space and time but varied along the arc. And, the velocity model along the northern Izu-Ogasawara arc reveals that the crustal thickness has the large variation and the Moho depth is tend to be shallower in south than those of north[6)]. Moreover, two boundaries separating the Izu-Ogasawara arc are confirmed by the bouguer gravity anomaly: one is located on southern Tori-shima and another is located around Kinyo seamount[7)]. It is inferred from large variation of the crustal structure along the arc that the nature of the crustal growth varies in the space.

The Sofu-gan tectonic line is crossing the Izu-Ogasawara arc in NE-SW direction and proposed as the boundary divided into the north and south parts of the arc[8)9)]. At this tectonic line, four structural characteristics (the distribution of bathymetric high, chemical compositions of rock samples in volcanic front, hypocenter distribution associated with the Pacific Plate subduction, and back arc depressions) differ at the south and north parts[8)9)]. Yuasa[10)] mentioned that these differences are reflected by the different development histories between two parts at the tectonic line. Moreover, on the basis of topography characters, this arc has topographic gap between Sumisu-shima and Tori-shima, which is divided into northern and central parts of the arc[11)]. However, to clarify the variation of the crustal structure, the seismic survey has not been conducted around this tectonic line.

The objectives of this study are to reveal the structural variation along the Izu-Ogasawara arc, especially in both sides of Sofu-gan tectonic line, and to understand the nature of crustal growth of subduction factory.

2. Experiment

We conducted a wide-angle seismic survey using an airgun array and ocean bottom seismographs (OBSs) to achieve above objectives (Figure 1). This cruise using R/V "Kaiyo" of Japan Agency for Marine-Earth Science

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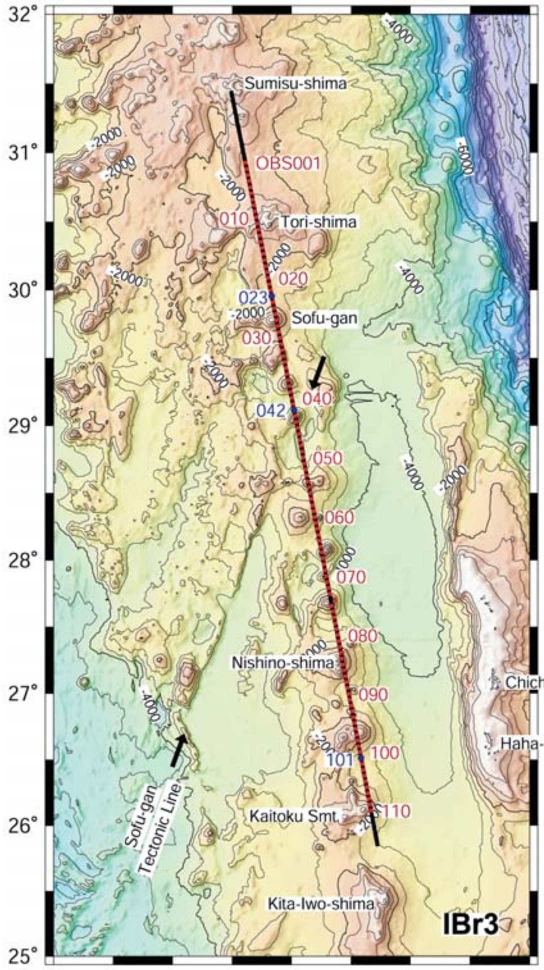

Figure 1: Map of the experimental area. A black line is the seismic line (IBr3). Red circles and three-digit numbers indicate OBS locations and OBS numbers, respectively. Blue circles with three-digit numbers are example OBSs shown in Figures 6-9.

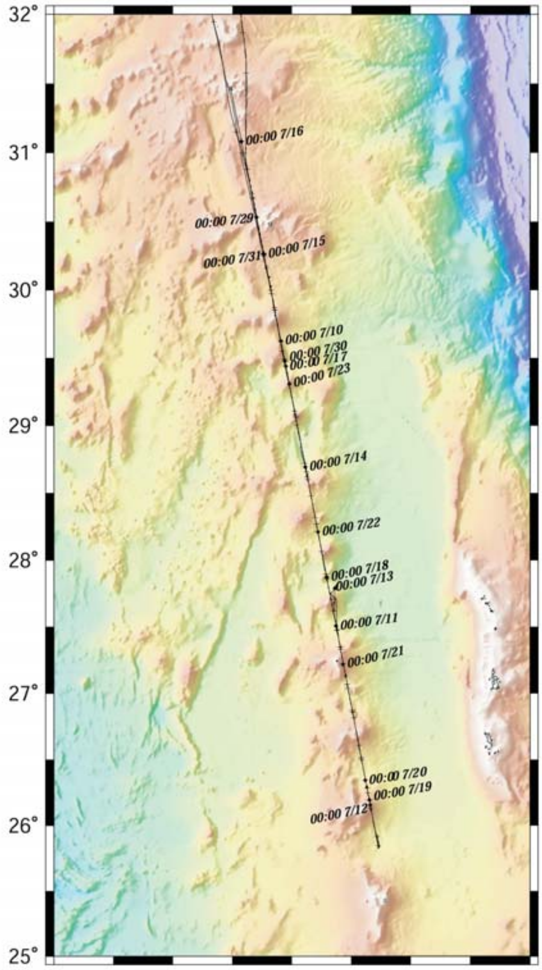

Figure 2: Map for ship's track line. Cross marks indicates ship position of every 6 hours.

and Technology (JAMSTEC) were from July 8 to August 1, 2005. The R/V Kaiyo departed from Yokosuka-shinko at July 8 and started OBS deployment from northern part of the seismic line until July 11. Airgun shooting carried out until July 19. And, we recovered OBSs in two periods from July 19 to 23 and from July 28 to 29 because of a typhoon. Then, we carried out a high-density shooting reflection experiment using G-gun array from July 29 to 30. Finally, we transited to JAMSTEC and arrived at August 1. The detailed activities are shown in Table 1 and Figure 2.

The seismic line of the cruise was about 635-km long along the Izu-Ogasawara arc traversing the main axis of volcanic front from the Sumisu-shima to north of the Kita-Iwo-shima. To clarify the structural variation of whole crustal scale, we need a long line to receive the deep penetrating signals with long offset. Moreover, the northern part of the seismic line was overlapped about 100-km with the former seismic line conducted in 2004[6] for understanding continuous structural variation of whole Izu-Ogasawara arc scale. The northernmost and southernmost shot points of the seismic line were 31-26.7970 N, 139-59.4767 E and 25-50.6674 N, 141-13.4040 E, respectively.

We used 110 OBSs and an airgun array with 12,000 cubic inches (200l) capacity as the source to reveal deep profiling of the crust and uppermost mantle. Along the seismic line, we towed a 12-channel hydrophone streamer to constrain the shallow structure because of the severe variation of the topography. Airgun signals were recorded by not only the OBSs but also the hydrophone streamer. Moreover, the high-density reflection experiment was conducted using small volume array (G-gun) and a 12-ch. hydrophone streamer from the north of the Sofu-gan to Kayo seamount to reveal the shallower structure than acoustic basement.

Table 1: Activity log during KY0507 cruise.

Date	Remarks
July 08	Departure from JAMSTEC, transit to OBS#001
July 09	OBS deployment (OBS#001-OBS#030)
July 10	OBS deployment (OBS#031-OBS#078)
July 11	OBS deployment (OBS#079-OBS#110) and airgun shooting from south to north
July 12	Airgun shooting from south to north and OBS retrieval and re-deployment of OBS#074
July 13	Airgun shooting from south to north
July 14	Airgun shooting from south to north
July 15	Airgun shooting from south to north and from north to south
July 16	Airgun shooting from north to south
July 17	Airgun shooting from north to south
July 18	Airgun shooting from north to south
July 19	Airgun shooting from north to south and OBS retrieval (OBS#110-#105)
July 20	OBS retrieval (OBS#104-OBS#085)
July 21	OBS retrieval (OBS#085-OBS#062)
July 22	OBS retrieval (OBS#062-OBS#037)
July 23	OBS retrieval (OBS#036-OBS#023) and transit to Tokyo Bay to escape the typhoon7
July 24	Staying in Tokyo Bay to recover the sea condition
July 25	Staying in Tokyo Bay to recover the sea condition
July 26	Staying in Tokyo Bay to recover the sea condition
July 27	Transit to survey area
July 28	OBS retrieval (OBS#001-OBS#010)
July 29	OBS retrieval (OBS#011-OBS#022) and high-density reflection experiment
July 30	High-density reflection experiment and OBS retrievals
July 31	Transit to JAMSTEC
August 01	Arrival to JAMSTEC

This experimental method is basically same as those described by Takahashi et al.[12].

2.1 Ocean Bottom Seismographs

We deployed 110 OBSs on the seismic line in this cruise with 5 km interval (Figure 1, Table 2). OBS locations were calculated by 2-D ray tracing using expected velocity model referring to those of the northern Izu-Ogasawara arc of previous studies[3)4)6)]. However, six OBSs were not recovered.

All OBSs were equipped with three-component geophones (vertical and two horizontal components perpendicular each other) using gimbal-leveling mechanisms and a hydrophone sensor. Natural frequency of these geophones was 4.5 Hz. Our OBSs and the digital recorder system were originally designed by Kanazawa and Shiobara[13] and Shinohara et al.[14]. The digital recorder used a 16-bit A/D converter and stored data on digital audiotape or a hard disk sampling continuously with original format[14]. The electronic power for the recorder system of OBS is supplied by rechargeable lithium-ion or alkali batteries. Above geophone sensors with gimbal-leveling mechanism, batteries and a recorder system are installed in 15 inch glass sphere by Benthos, Inc. The glass sphere is stored in the yellow hard hat. To enable easy OBS retrieval after arriving at sea surface, each OBS is attached to a flash light and a radio beacon with coded signals. An OBS is deployed by free fall and retrieved by melting releaser composed of stainless steel plates connecting the OBS with a weight when a transponder system receives 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 sea bottom are estimated by SSBL of the vessel's positioning system during the cruise. After the cruise, we edited the continuous OBS data with length of 90 s and SEG-Y format. At the same time, calibration of the OBS clock for GPS time was carried out using difference times between OBS clock and GPS time, which measured just before OBS deployment and just after OBS retrieval.

2.2 Large volume airgun shooting

To obtain the good quality OBS data and observe the phases from the deep structure, we carried out the high spatial shooting with 100 m interval (about 70-100 s interval depending on the ship speed) by twice shooting on a same line (Figure 3). Table 3 shows the shooting log. 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

Table 2: OBS information. Each recorder using DAT or hard disk is shown by each abbreviation of DAT or "HD". The "BTS" and "HIGH" means that makers of the hydrophone sensor are Benthos Inc. and High Tech Inc., respectively.

SITE	Deployment				Retrieval				HD type	hyd maker
	Time UTC	Coodinate Lat (N)	Lon (E)	Dep (m)	Time UTC	Coordinate Lat (N)	Lon (E)	Dep (m)		
1	7/9 00:33	30-55.6844	140-06.5826	1625	7/28 08:14	30-55.7331	140-06.9150	1627	DAT	BTS
2	7/9 01:05	30-52.9530	140-07.1844	1608	7/28 08:56	30-52.9563	140-07.4499	1616	DAT	BTS
3	7/9 01:35	30-50.2839	140-07.7685	1620	7/28 09:37	30-50.3379	140-08.0426	1617	HD	HIGH
4	7/9 02:03	30-47.6645	140-08.4058	1630	7/28 10:31	30-47.5872	140-08.4144	1632	HD	BTS
5	7/9 02:30	30-44.9750	140-09.0315	1607	7/28 11:14	30-45.0467	140-09.1770	1611	HD	BTS
6	7/9 02:57	30-42.3338	140-09.6643	1503	7/28 11:54	30-42.4381	140-09.8317	1520	HD	BTS
7	7/9 03:24	30-39.6298	140-10.2883	1465	7/28 12:47	30-39.6459	140-10.4500	1467	DAT	BTS
8	7/9 03:51	30-37.0940	140-10.9448	1454	7/28 13:33	30-37.2656	140-10.9969	1456	HD	BTS
9	7/9 04:20	30-34.4454	140-11.5460	1298	7/28 14:16	30-34.6114	140-11.6604	1303	HD	BTS
10	7/9 04:49	30-31.7939	140-12.0893	1103	7/28 15:10	30-32.0333	140-12.0716	1124	DAT	BTS
11	7/9 05:19	30-29.1650	140-12.7439	843	7/28 16:00	30-29.3290	140-12.7505	1036	HD	BTS
12	7/9 05:49	30-26.5069	140-13.3616	1124	7/28 16:49	30-26.6072	140-13.2967	---	HD	HIGH
13	7/9 06:19	30-23.8635	140-13.9546	1350	7/28 17:40	30-23.9108	140-13.9479	1345	HD	BTS
14	7/9 06:50	30-21.2078	140-14.5562	1492	7/28 18:30	30-21.2392	140-14.5977	1489	DAT	BTS
15	7/9 07:21	30-18.5599	140-15.1256	1652	7/28 19:23	30-18.5852	140-15.1658	1647	DAT	HIGH
16	7/9 07:52	30-15.9049	140-15.7541	1740	NA	NA	NA	NA	HD	BTS
17	7/9 08:20	30-13.2634	140-16.3638	1827	7/28 23:30	30-13.1728	140-16.3531	1819	DAT	BTS
18	7/9 08:43	30-10.6331	140-16.9784	1891	7/29 00:14	30-10.3988	140-16.7998	1886	HD	BTS
19	7/9 09:18	30-07.9989	140-17.6193	2029	7/29 00:47	30-07.8669	140-17.5685	2026	HD	BTS
20	7/9 09:45	30-05.3558	140-18.1912	2173	7/29 01:38	30-05.2545	140-18.1037	2168	HD	BTS
21	7/9 10:14	30-02.6747	140-18.8170	2063	7/29 02:13	30-02.5072	140-18.7336	2238	HD	BTS
22	7/9 10:43	30-00.0448	140-19.4121	2277	7/29 03:06	29-59.8453	140-19.3078	2275	DAT	BTS
23	7/9 11:14	29-57.3790	140-19.9957	2286	7/23 02:45	29-57.3010	140-20.0112	2283	HD	BTS
24	7/9 11:43	29-55.7315	140-20.5924	2210	7/23 02:10	29-54.0741	140-20.7477	2192	HD	BTS
25	7/9 12:11	29-52.1085	140-21.1698	1909	7/23 01:18	29-52.0335	140-21.2143	1890	DAT	BTS
26	7/9 12:42	29-49.4439	140-21.7506	1087	7/23 00:43	29-49.3751	140-21.8114	1052	HD	BTS
27	7/9 13:14	29-46.8154	140-22.3456	380	7/22 23:59	29-46.6559	140-22.2983	352	HD	BTS
28	7/9 13:45	29-44.1456	140-22.9402	1693	7/22 23:23	29-43.9925	140-22.7308	1647	HD	HIGH
29	7/9 14:16	29-41.4926	140-23.5519	2239	7/22 22:50	29-41.4758	140-23.3660	2219	HD	BTS
30	7/9 14:46	29-38.8421	140-24.1039	2444	7/22 21:56	29-38.7869	140-23.9389	2440	HD	BTS
31	7/9 15:16	29-36.1839	140-24.7223	2162	7/22 21:21	29-36.1280	140-24.6118	2080	DAT	BTS
32	7/9 15:45	29-33.5483	140-25.3067	1993	7/22 19:58	29-33.5023	140-25.1872	1949	HD	BTS
33	7/9 16:19	29-30.9117	140-25.9260	1820	7/22 19:07	29-30.8772	140-25.7563	1820	HD	BTS
34	7/9 16:49	29-28.2282	140-26.5297	2452	7/22 18:16	29-28.1692	140-26.3598	2453	HD	BTS
35	7/9 17:18	29-25.6108	140-27.1123	2737	7/22 17:23	29-25.5949	140-27.0148	2730	HD	HIGH
36	7/9 17:47	29-22.9372	140-27.7170	2559	7/22 16:38	29-23.0049	140-27.7231	2578	HD	BTS
37	7/9 18:16	29-20.3011	140-28.3010	1656	7/22 15:36	29-20.3459	140-28.3138	1690	HD	BTS
38	7/9 18:45	29-17.6537	140-28.9240	1723	7/22 14:49	29-17.6955	140-28.9584	1719	HD	BTS
39	7/9 19:16	29-14.9944	140-29.4835	2780	7/22 13:46	29-15.0137	140-29.4620	2757	DAT	BTS
40	7/9 19:47	29-12.3572	140-30.0683	3328	7/22 13:05	29-12.3383	140-30.0182	3300	HD	BTS
41	7/9 20:18	29-09.7318	140-30.6663	3318	7/22 12:07	29-09.7472	140-30.5324	3315	HD	BTS
42	7/9 20:50	29-07.0545	140-31.2600	2625	7/22 11:19	29-07.0614	140-31.1702	2631	HD	BTS
43	7/9 21:21	29-04.4127	140-31.7905	1136	7/22 10:31	29-04.3824	140-31.6253	1163	HD	BTS
44	7/9 21:53	29-01.7730	140-32.4303	2178	7/22 09:38	29-01.6905	140-32.2910	2119	HD	BTS
45	7/9 22:23	28-59.1188	140-33.0076	3084	7/22 08:45	28-59.0174	140-32.7248	3104	HD	BTS
46	7/9 22:55	28-56.4775	140-33.5741	3535	7/22 07:41	28-56.3250	140-33.2938	3542	HD	BTS
47	7/9 23:26	28-53.8213	140-34.1760	3700	7/22 07:04	28-53.6623	140-34.0014	3699	HD	BTS
48	7/9 23:57	28-51.1885	140-34.7478	3762	7/22 05:49	28-51.0904	140-34.7467	3766	HD	BTS
49	7/10 00:29	28-48.5401	140-35.3254	3787	7/22 05:08	28-48.4514	140-35.4099	3781	HD	BTS
50	7/10 01:01	28-45.8947	140-35.8910	3764	7/22 04:15	28-45.8313	140-35.8812	3766	HD	BTS
51	7/10 01:33	28-43.2322	140-36.4665	3398	7/22 03:26	28-43.2240	140-36.7011	3420	HD	BTS
52	7/10 02:06	28-40.5483	140-37.0166	2915	7/22 02:30	28-40.6123	140-37.2856	2912	HD	BTS
53	7/10 02:38	28-37.8917	140-37.5759	2417	NA	NA	NA	NA	HD	HIGH
54	7/10 03:08	28-35.2164	140-38.1739	1372	7/21 23:29	28-35.2227	140-38.3425	1313	HD	BTS
55	7/10 03:36	28-32.5998	140-38.8011	1736	7/21 22:33	28-32.6431	140-38.8336	1707	HD	BTS

Table 2: (continued).

SITE	Deployment				Retrieval				HD type	hyd maker
	Time UTC	Coodinate Lat (N)	Lon (E)	Dep (m)	Time UTC	Coordinate Lat (N)	Lon (E)	Dep (m)		
56	7/10 04:06	28-29.9691	140-42.2739	2670	7/21 16:26	28-16.7083	140-42.1894	2660	HD	BTS
57	7/10 04:35	28-27.3227	140-42.8711	2812	7/21 15:24	28-14.0263	140-42.6695	2800	HD	BTS
58	7/10 05:04	28-24.6700	140-43.4378	2983	7/21 14:44	28-11.3583	140-43.3706	2992	HD	BTS
59	7/10 05:33	28-22.0347	140-44.0003	3010	7/21 13:36	28-08.7197	140-43.9215	3113	HD	BTS
60	7/10 06:03	28-19.3812	140-44.5941	2227	7/21 13:02	28-06.0832	140-44.4863	2293	HD	BTS
61	7/10 06:32	28-16.7155	140-45.1777	1305	7/21 12:00	28-03.4221	140-45.1087	1338	HD	BTS
62	7/10 07:02	28-14.0794	140-45.7538	2329	7/21 11:09	28-00.7412	140-45.5965	2380	DAT	BTS
63	7/10 07:33	28-11.4131	140-46.3187	3285	7/21 10:34	27-58.0836	140-46.0780	3310	DAT	BTS
64	7/10 08:03	28-08.7707	140-46.8787	3290	7/21 09:49	27-55.4674	140-46.6695	3289	HD	BTS
65	7/10 08:32	28-06.1216	140-47.4252	2640	7/21 08:44	27-52.6686	140-47.3738	2617	DAT	BTS
66	7/10 09:05	28-03.4895	140-47.9997	3232	7/21 08:05	27-50.1375	140-47.8076	3228	HD	BTS
67	7/10 09:38	28-00.8229	140-48.5823	3023	7/21 06:55	27-47.5258	140-48.4303	3026	DAT	BTS
68	7/10 10:09	27-58.1677	140-49.1565	2263	7/21 06:08	27-44.8951	140-49.1635	2263	HD	HIGH
69	7/10 10:39	27-55.5201	140-51.9165	2233	7/21 04:59	27-42.5820	140-51.9979	2283	HD	BTS
70	7/10 11:08	27-52.8554	140-50.2935	1513	7/21 03:51	27-39.6077	140-50.2466	1511	HD	BTS
71	7/10 11:34	27-50.2135	140-50.8875	2458	7/21 02:55	27-37.0720	140-51.0529	2434	HD	BTS
72	7/10 12:00	27-47.5572	140-51.4480	3001	7/21 02:21	27-34.3813	140-51.6532	3002	DAT	BTS
73	7/10 12:27	27-44.9009	140-52.0220	3085	7/21 01:08	27-31.6337	140-52.2672	3120	HD	BTS
74	7.12 16:49	27-42.7271	140-52.5981	3113	7/21 00:42	27-29.0936	140-52.8158	3125	HD	HIGH
75	7/10 13:24	27-39.6048	140-53.1749	2830	7/20 23:34	27-26.5369	140-53.4335	2939	HD	BTS
76	7/10 13:52	27-36.9798	140-53.7399	2433	7/20 20:06	27-23.7992	140-53.7101	2466	HD	BTS
77	7/10 14:21	27-34.3055	140-54.3020	1673	NA	NA	NA	NA	HD	HIGH
78	7/10 14:48	27-31.6508	140-54.8685	1390	7/20 16:45	27-18.4477	140-54.8492	1400	HD	BTS
79	7/10 15:14	27-29.0141	140-55.4362	1084	7/20 15:51	27-15.7400	140-55.2514	1026	HD	BTS
80	7/10 15:40	27-26.3686	140-56.0055	1201	7/20 14:55	27-12.9067	140-55.8108	1183	HD	HIGH
81	7/10 16:05	27-23.7258	140-56.6405	1573	7/20 14:18	27-10.5033	140-56.5367	1529	HD	BTS
82	7/10 16:31	27-21.0773	140-57.1972	2236	NA	NA	NA	NA	DAT	BTS
83	7/10 16:56	27-18.4208	140-57.7624	2510	7/20 09:57	27-05.0965	140-57.7102	2508	DAT	BTS
84	7/10 17:20	27-15.7699	140-58.3115	2561	7/20 08:39	27-02.4399	140-58.2541	2622	HD	BTS
85	7/10 17:45	27-13.1211	140-58.8576	2487	7/20 07:33	26-59.7767	140-58.7400	2596	HD	BTS
86	7/10 18:09	27-10.5386	140-59.4116	2627	7/20 06:27	26-57.0715	140-59.2941	2627	HD	HIGH
87	7/10 18:34	27-07.8114	140-59.9670	2462	7/20 05:21	26-54.4604	140-59.8974	2443	DAT	BTS
88	7/10 19:00	27-05.1686	141-00.5234	1833	7/20 04:18	26-51.8991	141-00.5287	1784	DAT	BTS
89	7/10 19:24	27-02.5475	141-01.0900	1905	7/20 03:23	26-49.2317	141-01.1160	1912	HD	BTS
90	7/10 19:48	26-59.8910	141-01.6604	1708	7/20 02:18	26-46.5766	141-01.6437	1677	HD	BTS
91	7/10 20:12	26-57.2504	141-02.2094	1147	7/20 01:20	26-43.9640	141-02.1870	1135	DAT	BTS
92	7/10 20:37	26-54.6165	141-02.7941	900	7/20 00:38	26-41.3711	141-02.7945	895	HD	BTS
93	7/10 21:01	26-51.9737	141-03.3393	1650	7/20 00:04	26-38.6685	141-03.3596	1651	HD	BTS
94	7/10 21:26	26-49.3076	141-03.9012	2201	7/19 23:19	26-35.9852	141-03.8633	2201	HD	HIGH
95	7/10 21:50	26-46.6584	141-04.4719	2472	7/19 22:21	26-33.3574	141-04.3775	2474	HD	BTS
96	7/10 22:17	26-44.0103	141-05.0025	2641	7/19 20:58	26-30.6639	141-04.8399	2650	HD	HIGH
97	7/10 22:44	26-41.3595	141-05.5909	2739	7/19 19:30	26-28.0497	141-05.3631	2736	HD	BTS
98	7/10 23:13	26-38.6818	141-06.1270	2783	7/19 17:55	26-25.2194	141-05.9559	2792	HD	BTS
99	7/10 23:40	26-36.0322	141-06.6906	2730	7/19 16:27	26-22.7427	141-06.5169	2740	HD	HIGH
100	7/11 00:08	26-33.3887	141-07.2372	2611	7/19 14:48	26-19.9912	141-07.1053	2618	HD	BTS
101	7/11 00:35	26-30.7366	141-07.7987	2404	NA	NA	NA	NA	HD	BTS
102	7/11 01:03	26-28.0915	141-08.3661	2196	7/19 09:37	26-14.7330	141-08.3405	2175	HD	BTS
103	7/11 01:33	26-25.4455	141-08.9913	1942	7/19 08:16	26-12.0849	141-08.9823	1929	HD	HIGH
104	7/11 02:02	26-22.7850	141-09.5218	1437	7/19 03:56	26-09.4391	141-09.4597	1395	HD	BTS
105	7/11 02:28	26-20.1441	141-10.1063	1422	NA	NA	NA	NA	HD	HIGH
106	7/11 02:55	26-17.4631	140-39.3581	2425	7/21 21:47	28-29.9937	140-39.3317	2424	HD	BTS
107	7/11 03:20	26-14.8036	140-39.9465	2580	7/21 20:45	28-27.3554	140-39.9561	2583	HD	BTS
108	7/11 03:46	26-12.1625	140-40.4948	2466	7/21 19:46	28-24.5258	140-40.4555	2463	HD	HIGH
109	7/11 04:14	26-09.5318	140-41.1269	2409	7/21 18:44	28-22.0918	140-40.9639	2379	DAT	BTS
110	7/11 04:42	26-06.8582	140-41.6941	2482	7/21 17:32	28-19.4037	140-41.5521	2484	DAT	BTS

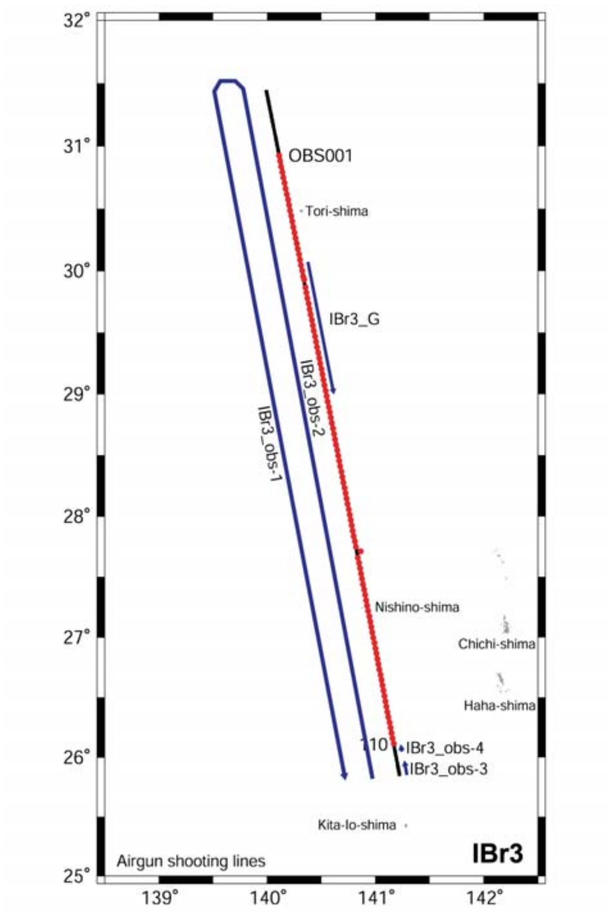

Figure 3: Map of airgun shooting. Blue arrows show a direction of the shooting.

chamber was 2,000 psi. The geometry of the seismic experiment is shown in Figure 4. The two floats with two airguns each were deployed from port and starboard sides, respectively. The airgun array's size is 34.56 m length x 21.3 m width. Airgun's position was located 134.67 m behind the ship position (distances from ship antenna to tail of ship, and from tail of ship to center of the airgun array, are 29.45 m and 105.22 m, respectively). As the differential global positioning system (DGPS) of the ship navigation system, Skyfix system was used (Naha as the nearest station). The accuracy of shooting position was about 10 m.

2.3 Multichannel hydrophone streamer and recording system

To reveal the shallow structure, we towed a 12-channel hydrophone streamer (STEALTHARRAY ST-48) during airgun shooting. (Figure 4a). The detailed descriptions are reported by Takahashi et al.[12]. The interval of each channel was 25m. The lengths of active section and read-in cable until the ship end are 300 m and 150 m, respectively. The sampling rate was 4 ms and the record length was 13.5 s. A seismic system of R/V "Kaiyo" consists of a navigation system with software SPECTRA, a recording system (StrataVisor NX Marine) and a gun controller system (GCS90), and these systems are connected via RTNμ (Figure 4b).

Table 3: Airgun shooting log.

IBr3_obs-2	Time (UTC)	Latitude (N)	Longitude (E)	Depth (m)	SP
First shot	2005/7/11 7:54	25° 50.6674'	141° 13.4040'	2964	10001
Stop shot	2005/7/11 8:51	25° 54.5064'	141° 12.6256'	2964	10037
Restart shot	2005/7/11 10:17	25° 50.6720'	141° 13.4303'	2966	20001
Stop shot	2005/7/12 11:42	27° 33.4452'	140° 51.6456'	3069	20967
Restart shot	2005/7/12 21:45	27° 30.2559'	140° 52.3320'	3107	30001
Last shot	2005/7/14 8:43	31° 26.4543'	139° 59.5658'	530	32224

IBr3_obs-1	Time (UTC)	Latitude (N)	Longitude (E)	Depth (m)	SP
First shot	2005/7/15 9:59	31° 26.7970'	139° 59.4767'	531	40001
Last shot	2005/7/18 20:18	25° 50.4851'	141° 13.4537'	2960	43165

IBr3_obs-3	Time (UTC)	Latitude (N)	Longitude (E)	Depth (m)	SP
First shot	2005/7/18 20:57	25° 50.6683'	141° 13.4176'	2967	50001
Last shot	2005/7/18 22:58	25° 57.9084'	141° 11.9036'	2858	50069

IBr3_obs-4	Time (UTC)	Latitude (N)	Longitude (E)	Depth (m)	SP
First shot	2005/7/19 0:35	26° 2.7529'	141° 10.8007'	2361	60001
Last shot	2005/7/19 1:29	26° 6.3516'	141° 10.1428'	1507	60071

IBr3_G	Time (UTC)	Latitude (N)	Longitude (E)	Depth (m)	SP
First shot	2005/7/29 4:53	30° 4.2217'	140° 18.3076'	2175	70001
Stop shot	2005/7/29 6:46	29° 59.9039'	140° 19.3841'	2280	70274
Restart shot	2005/7/29 6:49	29° 59.6652'	140° 19.4375'	2283	80001
Last shot	2005/7/29 22:21	28° 59.9190'	140° 32.7566'	2853	82250

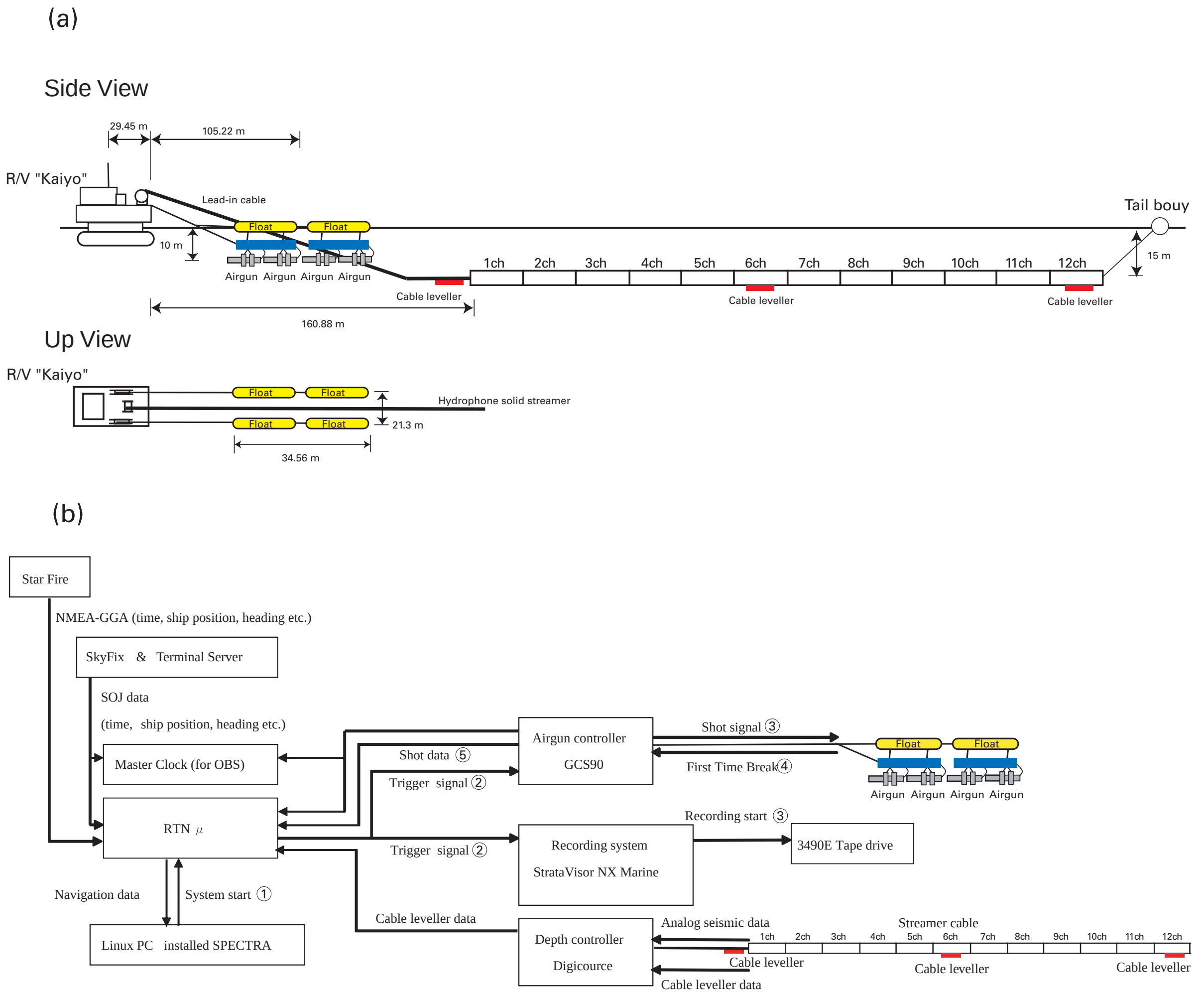

Figure 4: MCS system (after Takahashi et al., 2005). (a) Geometry of airgun system and the hydrophone streamer. (b) Flow chart for the MCS recording system

2.4 High density shooting with small volume airgun array (G-gun)

A small volume airgun array was composed of four 150 cu. in. airguns (G-gun: Bolt Inc.) in order to reveal the fine shallow structural images (Figure 5). The four G-gun were shot simultaneously in every 50-m, which was about 25 s. Prior to the survey recording, a shooting test was conducted to design the preferable source signature with varied shooting delays, and the adopted pattern was no delay and simultaneous shooting. G-gun's position was located 59.45 m behind the ship position (distances from ship antenna to tail of ship, and from tail of ship to center of the airgun array, are 29.45 m and 30.00 m, respectively). The controlling and recording system was same as that of ordinary shooting and recording mentioned above.

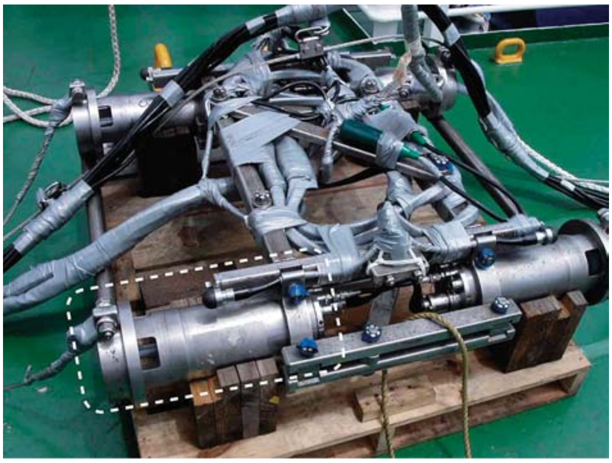

Figure 5: Photograph for G-gun array. G-gun array is composed of four 150 cu. in. G-guns fixed with a metal flame. White dotted rectangle shows a G-gun.

3. Data

In this chapter, we introduce examples of the seismic data obtained by OBSs and MCS. Vertical components of OBS#23, OBS#42 and OBS#101, and horizontal components of OBS#42 are described section 3.1. MCS data are described below section 3.2.

3.1 OBS

We retrieved 104 OBSs and did not retrieved 6 OBSs. Except some OBS data with recorder troubles, the data quality of available OBSs is basically good and we can trace the first phases on vertical records until about 100 km distance from each OBS. Horizontal records also show good quality despite of poorer S/N ratio than the vertical, and we can see converted S arrivals until about 100 km from the OBS. We describe characteristics of OBS data using vertical record sections of OBS#23 (Figure 6), OBS#42 (Figure 7) and OBS#101 (Figure 8) as follows.

OBS#23 was deployed in deep between Tori-shima and Sofu-gan. We can trace first arrivals until an offset of 130 km from the OBS (Figure 6). The apparent velocities of first phases in north sides are 2.6, 4.9, 5.6, 6.2, 6.6 and over 7 km/s in offsets of 5-7, 7-10, 10-14, 14-25, 25-40 and over 70 km, respectively. In southern side, apparent velocities of first arrivals are 2.8, 4.2 and 6.3 km/s in offsets of 5-7, 7-9 and 9-12 km, respectively. Variation of these apparent velocities drawing concave shape can be seen at offsets of 50-70 km in northern side and 12-32, 35-55 and 65-85 km due to some seamounts. Reflections from the Moho (PmP) with high amplitudes can be also seen at an offset of 100-130 km.

OBS#42 was deployed in deep near Kayo seamounts. On northern side, the apparent velocities are 2.4, 5.5 and over 7 km/s in offsets of 5-8, 8-10 and over 35 km, respectively (Figure 7). In southern side, the apparent velocities of these phases are 4.3, 6.3 and over 7.0 km/s in offsets of 18-22, 22-30 and over 30 km, respectively. We can see the apparent velocities variation of first phases at a distance of 10-30 km in northern side and 3-18 and 30-80 km in southern side. Reflections from the Moho (PmP) with high amplitudes can be seen at a northern offset of 80-120 km.

OBS#101 was deployed between Kaikata and Kaitoku seamounts. We can trace first phases in northern side with apparent velocities of 3.5, 5.0 and 4.8 km/s in offsets of 5-8, 8-12 and 47-53 km, respectively (Figure 8). In southern part, the apparent velocities of first phases are 2.6, 3.8, 4.7 and 6.2 km/s in offsets of 5-7, 7-12, 12-

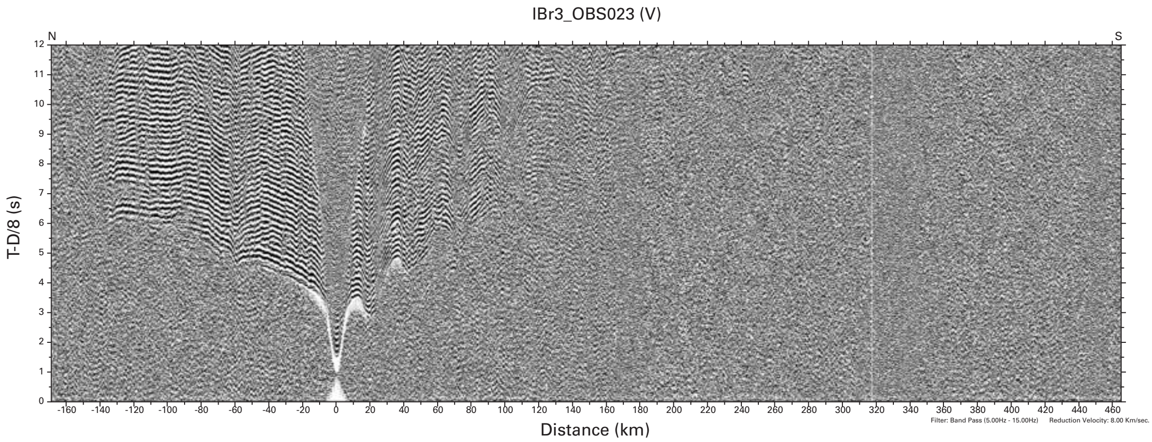

Figure 6: Vertical record section recorded by OBS#23. All traces are filtered by 5-15 Hz. Vertical and horizontal axes are offsets from OBS and reduced traveltimes by 8 km/s.

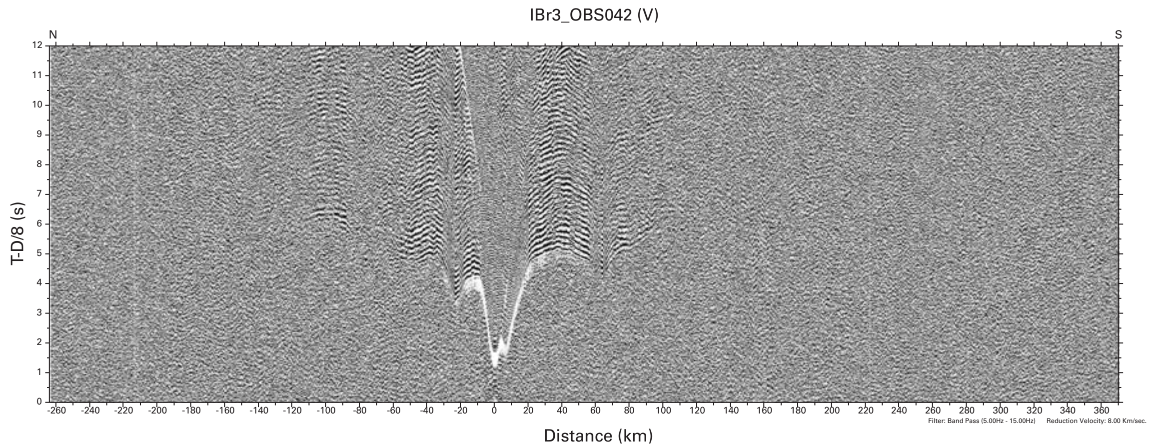

Figure 7: Vertical record section recorded by OBS#42. The details are same as for Figure 6.

16 and 16-24 km, respectively. These variation is also effected the topography near the Kaitoku seamount.

Figures 9a and 9b indicate two horizontal components of OBS#42 crossing perpendicularly each other. We can see many phases with same apparent velocities to P-wave. This record section seems to have much PSP phases. At an offset of 40-90 km and 8-11 s in reduced time by 4.62 km/s in southern side, we can see some phases with slow apparent velocities and these phases probably correspond to PSS phases.

3.2 MCS

The reflection data recorded by a 12-channel hydrophone streamer has also enough quality to pick the acoustic basement (Figure 10a). Applied flows were a collection of spherical divergence, editing bad quality

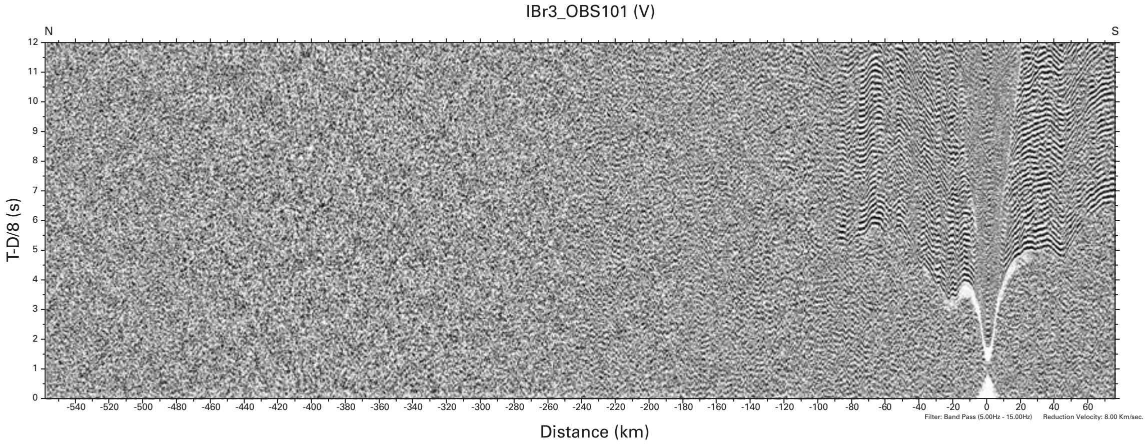

Figure 8: Vertical record section recorded by OBS#101. The details are same as for Figure 6.

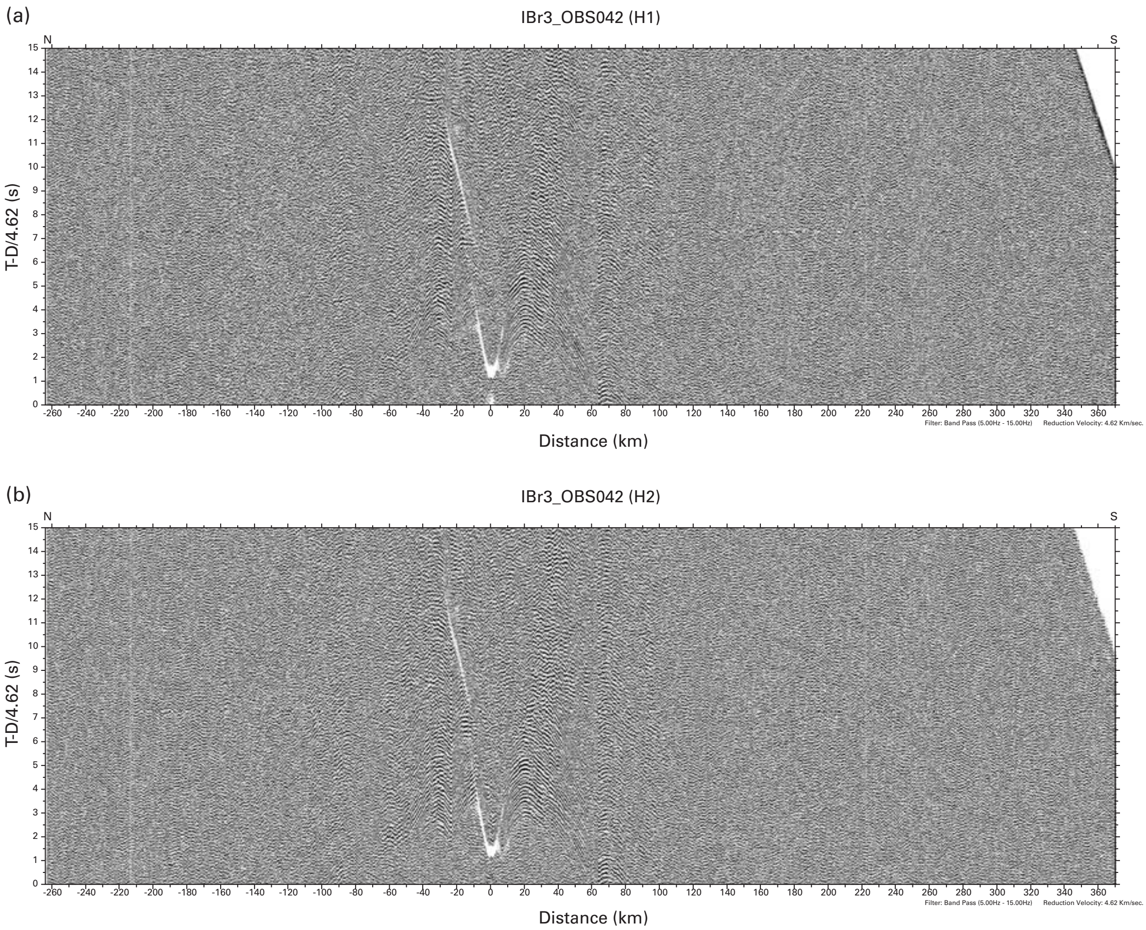

Figure 9: Horizontal record sections recorded by OBS#42. All traces are filtered by 5-15 Hz. The reduced velocity is 4.62 km/s. (a) Horizontal component-1. (b) Horizontal component-2.

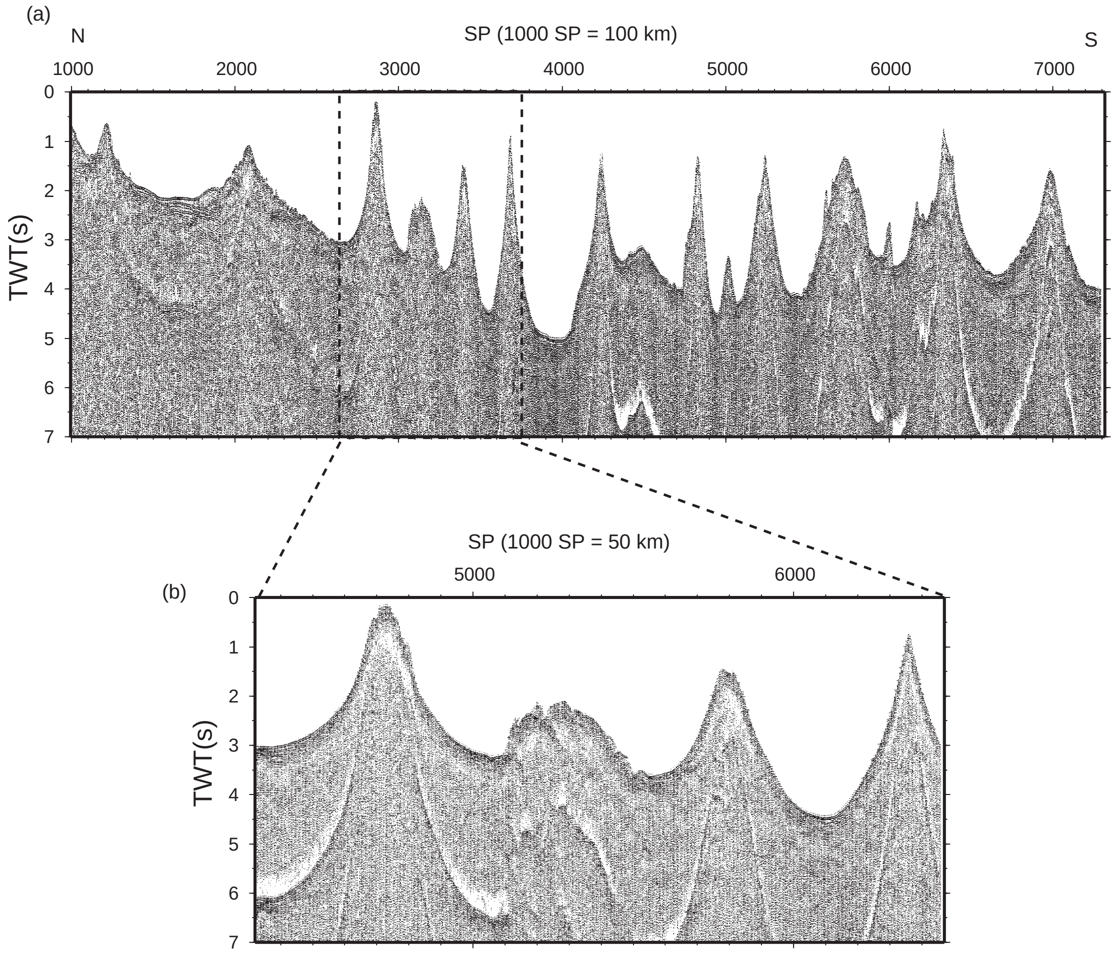

Figure 10: (a) MCS profile along the seismic line. Vertical and horizontal axes are two-way traveltime (s) and shotpoint (SP), respectively (1000 SP = 100 km). Dotted rectangle indicates the G-gun shooting location. (b) G-gun profile along the seismic line. Vertical and horizontal axes are two-way traveltime (s) and shotpoint (SP), respectively (1000 SP = 50 km).

traces, a predictive deconvolution filtering using an operator length of 300 ms and an predictions distance of 24 ms, stacking at shot points, a time variant bandpass filter of 3-55 Hz and the auto gain control. For the G-gun data, the range of bandpass filter is 5-55 Hz since the high frequency signals (Figure 10b). Because of the channel interval of 25 m and the shot interval of 200 m and the fold number was less 1.0, we stacked the traces not the CDPs but the shot points.

The profiles show that rough topographic features of seamounts (Figure 10). The seamounts have little sediments on the summits. Bathymetric deep between seamounts are sediments recognized part, and thick sediments are distributed in limited area as northern part of the seismic line.

4. Summary

In this paper, we summarize the seismic experiment in the central and southern Izu-Ogasawara arc area and introduce the seismic data of OBS and MCS data. The recording condition is good enough to trace the first arrival phases about 100 km offsets. From the data, we will reveal the structural variation of central and southern Izu-Ogasawara arc area especially crossing the Sofu-gan tectonic line. Moreover, we will estimate the volume and rate of continental crustal growth.

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Technician	Miho Ido
Technician	Tomoaki Kudoh
Technician	Kimiko Serizawa

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Chief Officer	Kouji Samejima
Chief Officer	Rikita Yoshida
Second Officer	Akihisa Tsuji
Third Officer	Kazunori Kamiya
Assistant Officer	Atsushi Takao
Chief Engineer	Tatsuo Jidozono
First Engineer	Kazuhiko Kaneda
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