High density single-channel seismic profiles obtained during KY05-06 cruise in the Sagami Bay, Japan

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Abstract In May, 2005, intensive single channel seismic surveys have been successfully completed in Sagami Bay area, central Japan, during the KY05-06 cruise using R/V KAIYO of JAMSTEC (Japan Agency for Marine-Earth Science and Technology). We obtained 22 SCS profiles in the overall Sagami Bay area, and 37 shallow and deep profiles around the Hatsushima cold seep communities in the western Sagami Bay. Very clear acoustic images were captured down to 1 sec. (TWT) after some editing, band-pass filtering and time migration. We present here the seismic profiles obtained during the KY05-06 cruise.

Keywords: Sagami-bay, Single Channel Seismic Survey, Hatsushima cold seep community, Cabled observatory

1. Introduction

The Sagami Bay, central Japan, is known to be in the most complicated tectonics in the world. Subduction of Philippine Sea Plate beneath mainland Honshu is significantly obstructed by the collision of Izu Peninsula. The volcanic front of Izu-Bonin Arc extends northward from Izu-Oshima through Higashi-Izu monogenetic volcanoes. Active cold seep biological communities are distributed along the escarpment of the eastern rim of the Izu Peninsula. Extensive earthquake swarms repeatedly occur in the eastern Izu region (Okada et al., 2000).

Intensive geological, geophysical, geochemical and biological surveys have been carried out in this area. One of the most basic items is seismic reflection survey (single-channel or multi-channel), which has been conducted in Japan (e.g. Iwabuchi et al., 1990; Kato et al., 1993). However, most records were in an analog format and are difficult to investigate in detail. Besides, intervals between survey lines are too sparse to see any hydrogeological features in detail beneath the Hatsushima cold seep site.

We conducted high-density single channel seismic (SCS) survey in overall Sagami Bay at every 4 km interval (Fig. 1), and around the Hatsushima cold seep site at 0.1-0.2 miles interval (Fig. 2). We here briefly report

Figure 1: Index map of Sagami Bay with SCS survey tracks. Square indicates the area for intensive survey off Hatsushima.

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Figure 2: (Upper panel) SCS survey track in the Hatsushima site (the area shown as a square in Fig. 1). (Lower panel) Other SCS survey track around the Hatsushima site.

the result of KY05-06 cruise, providing preliminary profiles obtained during this cruise.

2. Data acquisition

2.1 Overall Sagami Bay Survey

SCS survey was carried out from April 25, 2005 to May 5, 2005, using JAMSTEC R/V KAIYO with a total length of approx. 852 km (Fig. 1). The GI gun system was used, with the line spacing 4 km.

Survey lines were planned based on the following considerations;

- (1) Survey lines would cover Sagami-bay area extensively.
- (2) Direction of survey lines would be decided based on the structural trend in this area.
- (3) Survey lines will be prepared to be convenient for the construction of structural map, though resolution in the deeper part is limited because of SCS data collection.
- (4) The southern part of Sagami Bay has a very heavy, ship traffic lane for Tokyo Bay, so survey lines were adjusted from the points of safe ship traffic.

Survey line information is summarized in Table 1.

2.2 Hatsushima Intensive Survey

SCS survey was carried out from May 5 to May 10, 2005, onboard JAMSTEC R/V KAIYO with a total

Figure 3: Photographs of the GI gun system

length of approx. 300 km (Fig. 2). A dense grid survey was carried out, centered at the Hatsushima cold seep site, with the line spacing 0.1-0.2 miles. In order to obtain shallow structure as well as deeper imagery, we first deployed GI gun system (105 cuin, steaming at 5 knots, 8 sec. shot interval, 50 m streamer length). After that CDEX's cluster gun system was replaced to cover the shallower images at some lines (20 cuin, steaming at 3 knots, 3 sec. shot interval, 20 m streamer length) (Fig. 3). Table 2 shows this survey line information.

3. SCS system and processing summary

3.1 GI gun system

The GI gun system is effective to obtain acoustic images down to 1 sec (TWT).

GI gun

Total volume: 355 cuin (Generator 250 cuin/ Injector 105 cuin)

Towing depth: 3 m

Source pressure: 2,000 psi (136 atm.)

Pop interval: 8 seconds

Streamer

Seamap streamer cable was used for the first line SG-05SCS-05. Since noisy traces appeared for this cable, we replaced it with SIG16 streamer cable, which worked fine throughout the rest of the lines.

Seamap streamer specifications:

Streamer length: 10 m

No. of Hydrophones: 20

Hydrophone interval: 0.5 m

Type of Hydrophone: SQ5 Sensor Technology

Frequency: 1 Hz - 6,000 Hz +/-0.5 dB

Preamplifier: 22.2 dB

SIG16 streamer specifications:

Streamer length: 50 m

No. of Hydrophones: 48

Hydrophone interval: 1 m

Type of Hydrophone: SIG

Frequency: 10 Hz - 1,000 Hz +/-1 dB

Table 1: SCS line information for the overall Sagami Bay survey

Line Name	Starting point	Ending point	Shooting Direction	SP number	Line length (km)
SG-05SCS-01	35° 12' 02.17" N 139° 09' 50.03" E	35° 14' 57.88" N 139° 13' 59.51" E	NE	2 - 495	8.15
-02	35° 15' 01.83" N 139° 18' 06.30" E	35° 10' 12.06" N 139° 11' 15.73" E	SW	2 - 821	13.53
-03	35° 04' 32.88" N 139° 07' 27.24" E	35° 14' 54.44" N 139° 22' 08.16" E	NE	20 - 1695	27.65
-04	35° 15' 01.50" N 139° 26' 06.15" E	35° 04' 01.30" N 139° 10' 31.49" E	SW	2 - 1821	30.03
-05	34° 59' 25.11" N 139° 08' 06.68" E	35° 14' 38.15" N 139° 29' 44.38" E	NE	13 - 2517	41.33
-06-1	35° 13' 48.34" N 139° 32' 40.32" E	35° 11' 59.33" N 139° 29' 53.31" E	SW	7 - 321	5.20
-06-2	35° 13' 02.63" N 139° 31' 33.14" E	34° 58' 32.06" N 139° 10' 49.53" E	SW	19 - 2375	38.89
-07	34° 55' 46.30" N 139° 10' 49.84" E	35° 11' 13.05" N 139° 33' 00.89" E	NE	26 - 2568	41.96
-08-1	35° 09' 05.45" N 139° 34' 03.37" E	34° 58' 26.22" N 139° 18' 51.21" E	SW	2 - 1783	29.40
-08-2	34° 58' 42.30" N 139° 19' 16.57" E	34° 49' 27.16" N 139° 06' 07.57" E	SW	37 - 1568	25.28
-09	34° 46' 32.87" N 139° 06' 05.11" E	35° 06' 43.10" N 139° 34' 48.29" E	NE	523 - 3736	53.03
-10	35° 05' 28.67" N 139° 36' 53.95" E	34° 44' 02.79" N 139° 06' 32.91" E	SW	2 - 3832	63.21
-11	34° 42' 33.73" N 139° 08' 33.97" E	35° 04' 03.83" N 139° 39' 06.10" E	NE	2 - 3445	56.83
-12-1	35° 02' 53.65" N 139° 41' 27.06" E	34° 49' 00.50" N 139° 21' 30.12" E	SW	10 - 2477	40.72
-12-2	34° 40' 42.56" N 139° 09' 49.87" E	34° 48' 57.44" N 139° 21' 35.38" E	NE	50 - 1359	21.62
-13	34° 48' 35.36" N 139° 25' 03.14" E	35° 00' 24.16" N 139° 41' 52.66" E	NE	24 - 1921	31.32
-D	34° 56' 54.69" N 139° 18' 14.35" E	35° 06' 53.82" N 139° 07' 54.66" E	NW	27 - 1408	22.80
-E-1	35° 06' 56.41" N 139° 11' 16.44" E	34° 56' 00.07" N 139° 22' 39.18" E	SE	2 - 1544	25.46
-E-2	34° 50' 26.66" N 139° 28' 13.87" E	34° 57' 14.92" N 139° 21' 22.08" E	NW	9 - 958	15.68
-F	34° 57' 23.94" N 139° 24' 36.24" E	35° 10' 58.14" N 139° 10' 29.69" E	NW	6 - 1897	31.22
-G-1	35° 13' 29.36" N 139° 11' 24.69" E	34° 58' 53.63" N 139° 26' 38.70" E	SE	11 - 2009	32.98
-G-2	35° 00' 03.81" N 139° 25' 21.98" E	34° 53' 14.40" N 139° 32' 22.28" E	SE	18 - 958	15.53
-H-1	35° 00' 14.47" N 139° 28' 44.83" E	35° 14' 57.38" N 139° 13' 21.80" E	NW	11 - 2108	34.62
-H-2	34° 54' 43.30" N 139° 34' 28.12" E	35° 01' 36.20" N 139° 27' 20.55" E	NW	2 - 1004	16.55
-I	35° 15' 01.14" N 139° 16' 47.11" E	35° 04' 16.16" N 139° 28' 05.20" E	SE	6 - 1531	25.18
-J-1	35° 05' 02.24" N 139° 30' 46.01" E	35° 14' 56.17" N 139° 20' 22.50" E	NW	12 - 1433	23.46
-J-2	35° 06' 03.96" N 139° 29' 35.65" E	34° 57' 31.76" N 139° 38' 19.03" E	SE	2 - 1175	19.37
-K-1	35° 15' 00.00" N 139° 23' 48.16" E	35° 11' 26.10" N 139° 27' 26.66" E	SE	8 - 529	8.61
-K-2	35° 15' 03.12" N 139° 23' 45.43" E	35° 04' 24.94" N 139° 34' 41.25" E	SE	2 - 1538	25.36
-L-1	35° 08' 38.46" N 139° 33' 55.85" E	35° 11' 42.46" N 139° 30' 41.30" E	NW	3 - 443	7.28
-L-2	35° 15' 07.78" N 139° 27' 06.81" E	35° 11' 40.66" N 139° 30' 43.08" E	SE	15 - 504	8.09
-L-3	35° 00' 12.99" N 139° 42' 21.43" E	35° 05' 27.66" N 139° 36' 56.02" E	NW	2 - 718	11.83
				Total	852.17

Line lengths in this table were derived from the calculation of number of shots multiplied by 16.5 m (8 seconds pop interval approximately corresponds 16.5 m when 4 knots cruising speed).

Table 2: SCS line information for the intensive Hatsushima survey

Line Name	Starting point	Ending point	Shooting Direction	SP number	Line length (km)
KY0506H-01	35° 02.6923' N 139° 12.8275' E	34° 58.8048' N 139° 11.0900' E	SSW	2 - 357	4.22
KY0506H-02	34° 58.4643' N 139° 12.3770' E	35° 02.6886' N 139° 14.1373' E	NNE	2 - 475	7.82
KY0506H-03	35° 02.4785' N 139° 14.1705' E	34° 58.4283' N 139° 12.4696' E	SSW	1323 - 1706	6.34
KY0506H-04	35° 02.4161' N 139° 14.2907' E	34° 58.3987' N 139° 12.5883' E	SSW	479 - 853	6.19
KY0506H-05	34° 58.4514' N 139° 12.7613' E	35° 02.5788' N 139° 14.4741' E	NNE	1710 - 2156	7.38
KY0506H-06	34° 58.4785' N 139° 12.9088' E	35° 02.5365' N 139° 14.5949' E	NNE	857 - 1319	7.64
KY0506H-07	35° 02.3306' N 139° 14.6292' E	34° 58.3834' N 139° 12.9686' E	SSW	2160 - 2532	6.15
KY0506H-08	35° 02.3286' N 139° 14.7419' E	34° 58.2658' N 139° 13.0566' E	SSW	442 - 827	6.37
KY0506H-09	35° 01.9235' N 139° 16.2376' E	34° 57.8544' N 139° 14.5321' E	SSW	2021 - 2406	6.37
KY0506H-10	34° 58.3517' N 139° 13.3428' E	35° 02.4043' N 139° 15.0572' E	NNE	2 - 438	8.04
KY0506H-11	34° 58.3009' N 139° 13.5754' E	35° 02.3576' N 139° 15.2722' E	NNE	831 - 1251	6.95
KY0506H-12	35° 02.1644' N 139° 15.4574' E	34° 58.0813' N 139° 13.7305' E	SSW	1255 - 1629	6.19
KY0506H-13	34° 58.1545' N 139° 14.0709' E	35° 02.2138' N 139° 15.7846' E	NNE	1633 - 2017	6.35
KY0506H-A	35° 01.2004' N 139° 18.9594' E	35° 03.3092' N 139° 11.3749' E	WNW	3503 - 4161	10.87
KY0506H-B	35° 03.0372' N 139° 11.4750' E	35° 00.9327' N 139° 19.0499' E	ESE	2947 - 3499	9.12
KY0506H-C	35° 00.7888' N 139° 18.8077' E	35° 02.9210' N 139° 11.2140' E	WNW	2310 - 2943	10.46
KY0506H-D	35° 02.5494' N 139° 11.7493' E	35° 00.5505' N 139° 18.9190' E	ESE	1776 - 2306	8.76
KY0506H-E	35° 00.4223' N 139° 18.7553' E	35° 02.4075' N 139° 11.5511' E	WNW	1147 - 1772	10.33
KY0506H-F	35° 02.0846' N 139° 11.8272' E	35° 00.1820' N 139° 18.7272' E	ESE	624 - 1143	8.58
KY0506H-G	35° 00.0424' N 139° 18.5374' E	35° 01.9475' N 139° 11.6917' E	WNW	2 - 620	10.21
KY0506H-H	35° 01.8240' N 139° 11.3985' E	34° 59.8062' N 139° 18.5729' E	ESE	2890 - 3407	8.55
KY0506H-I	34° 59.6422' N 139° 18.4420' E	35° 01.6875' N 139° 11.2051' E	WNW	2292 - 2886	9.82
KY0506H-J	35° 01.1616' N 139° 12.2238' E	34° 59.4330' N 139° 18.4158' E	ESE	1825 - 2288	7.66
KY0506H-K	34° 59.2885' N 139° 18.1780' E	35° 01.1440' N 139° 11.5856' E	WNW	1239 - 1821	9.62
KY0506H-L	35° 01.1731' N 139° 10.6699' E	34° 59.0420' N 139° 18.2670' E	ESE	2579 - 3153	9.49
KY0506H-M	35° 01.0743' N 139° 10.6367' E	34° 58.9265' N 139° 18.3530' E	ESE	654 - 1235	9.60
KY0506H-N	34° 58.9059' N 139° 18.0740' E	35° 01.0302' N 139° 10.4532' E	WNW	1951 - 2574	10.28
KY0506H-O	34° 58.8110' N 139° 17.9767' E	35° 00.9519' N 139° 10.3981' E	WNW	2 - 650	10.71
KY0506H-P	35° 00.8007' N 139° 10.5002' E	34° 58.6529' N 139° 18.1459' E	ESE	1405 - 1946	8.94
KY0506H-Q	34° 58.9571' N 139° 16.3319' E	35° 00.6646' N 139° 10.2618' E	WNW	912 - 1401	8.09
KY0506H-R	35° 00.4153' N 139° 10.3483' E	34° 58.7716' N 139° 16.2264' E	ESE	488 - 908	6.95
KY0506H-S	34° 58.6444' N 139° 15.9770' E	35° 00.2936' N 139° 10.1255' E	WNW	2 - 484	7.97
KY0506H-T	35° 00.0455' N 139° 10.2017' E	34° 58.3893' N 139° 16.0797' E	ESE	1897 - 2309	6.81
KY0506H-U	34° 58.2552' N 139° 15.7926' E	34° 59.9069' N 139° 09.9530' E	WNW	1404 - 1893	8.09
KY0506H-V	34° 59.6508' N 139° 10.0595' E	34° 58.0137' N 139° 15.9187' E	ESE	980 - 1400	6.95
KY0506H-W	34° 57.8770' N 139° 15.6841' E	34° 59.5244' N 139° 09.8091' E	WNW	471 - 976	8.35
KY0506H-X	34° 59.2920' N 139° 09.8692' E	34° 57.6365' N 139° 15.7533' E	ESE	2 - 467	7.69
Total					299.91

Line lengths in this table were derived from the calculation of number of shots multiplied by 16.5 m (8 seconds pop interval approximately corresponds 16.5 m when 4 knots cruising speed).

Preamp: 39 dB

The towing depth of SIG16 streamer was variable from 3.1 m to 6.7 m below sea surface.

Recording system

The Triton Erics' Delph Seismic system was used for data recording. The main feature of the system and parameters are as follows:

Type of system: Delph Seismic

Monitor: EPC The model GSP-1086 Printer

Recording format: SEG-Y

Recording length: 7 seconds

Sampling rate: 1 ms

3.2 Cluster gun system

The cluster gun system is effective to obtain images for the shallower part, down to a few hundred meters. Fig. 4 shows the photograph of the system onboard KAIYO.

Specifications:

(1) Manufacturer:	Bolt Technology
(2) Type of airgun:	2800LL-X Cluster
(3) Volume:	20 cuin × 2
(4) Air pressure:	2000 psi
(5) Source Depth:	1.3 m
(6) Peak-peak:	7 bar-m
(7) Primary to bubble:	43.8
(8) Dominant frequency(-6 dB):	50 Hz - 530 Hz
(9) Depth sensor:	N/A
(10) Gun Controller:	GCS90

3.3 Data Processing

SCS reflection profiles are processed for the purpose of quality control. The data processing for the overall Sagami Bay profiles contains noisy-trace editing, 14-180 Hz band-pass filtering and time migration ($V_p = 1500$ m/s). The data processing of Hatsushima site profiles contains noisy-trace editing, 14-180 Hz (GI gun), 45-500 Hz (Cluster gun) band-pass filtering and

Figure 4: Photograph of the cluster gun system ready for launching onboard KAIYO.

time migration ($V_p = 1500$ m/s).

4. Outline of obtained data

Approx. 852 km of SCS data was recorded for the overall Sagami Bay survey. And it was particularly mentioned that 5 survey lines (total length of approx. 79 km) crossing ship lane for Tokyo bay were recorded successfully during midnights of so called "golden week". The total ship time for this survey was 9 days & 20 hours, and SCS survey time was 4 days & 19 hours (49% of the total ship time). The attached SCS images (Fig. 5) were displayed through FOCUS software, but 120 ms system delay and datum correction were not yet applied.

For the Hatsushima intensive survey, we could obtain very clear images down to 1 sec. (TWT). An intrusion to the east of Izu Peninsula can be traced for the most of E-W lines (C through U). This is also clearly recognized at a crossing line 9. A diaper-like structure, with its diameter ~500 m, was identified at lines 9 and U.

The profiles shown in this report is preliminary. We need to correct for the position of the streamer first. Final interpretation will be reported afterwards.

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Figure 5: SCS profiles in the overall Sagami Bay area. Vertical axis is a two-way travel time in second. Horizontal axis is the shot point (SP) number, with relative distance scale attached.

Figure 5: (Continued)

Figure 5: (Continued)

Figure 5: (Continued)

Figure 6: Seismic reflection profiles of line A-Z (Hatsushima site) by using GI gun in the WNW-ESE direction. Vertical axis is a two-way travel time in second. Horizontal axis is the SP number, with relative distance scale attached.

Figure 6: (Continued)

Figure 6: (Continued)

Figure 7: Seismic reflection profiles of line 01-13 (Hatsushima site) by using GI gun in the NNE-SSW direction. Vertical axis is a two-way travel time in second. Horizontal axis is the SP number, with relative distance scale attached.

Figure 7: (Continued)

Figure 8: Seismic reflection profiles obtained using Cluster gun. The vertical axis is Two way travel time in sec. Vertical axis is a two-way travel time in second. Horizontal axis is the SP number, with relative distance scale attached. Note that the scale of vertical axis is different for each profile.