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Report on DELP 1989 Cruise in the TTT Junction Areas Part 1: General Outline

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Abstract

This report describes mainly the results of a DELP research cruise in 1989 to the western part of Sagami Trough off southern coast of Kanto Plain, and the trench-trench-trench triple junction off the Boso Peninsula, Kanto, Japan. The cruise was planned as one of the programs of a joint study by two DELP seafaring research groups, JGDGBAB and JDRGDSOL (refer to authorship footnotes). Preliminary results of studies on the seismic structures, heat flow, and marine geomagnetic measurements are obtained with the aim of clarifying the geometrical and mechanical scheme of the collision and subduction between two oceanic plates, the Philippine Sea Plate subducting underneath the North American Plate (Japan land mass), and collision and distortion among three plates: Pacific Plate, Philippine Sea Plate and North American Plate (Japan land mass). The concept 'Japan land mass' does not seem to be equivalent to the plates, but we use this term because it is not unequivocally understood whether the northeastern-eastern part of the Japan land mass, including the Kanto Plain, Tohoku and Hokkaido, belongs to the North American Plate or the Eurasian Plate (eg. Seno, 1985). However, we prefer to assign this part of the Japan land mass to the North American Plate all through this article just for convenience in spite of its ambiguity.

The scientific objectives, area surveyed, cruise period, terms of observation, filing of data, and names of participants in this program, and some of the main results and interpretations obtained so far, are presented in Part 1. More details of data acquisition, analysis and interpretation are presented in the later parts. Also described in Part 1 are some new results and findings obtained very recently at the time of this writing and not mentioned in other parts. Data and interpretation obtained by other cruises related to the present program are also referred to in the concluding section of this part.

1. Introduction

These scientific objective of the DELP cruise is to study "Tectonic activity and structure in the area of interaction of number of oceanic and continental plates around the southeastern corner of the Japanese Mainland". The objective area includes the world's only trench-trench-trench triple junction near the junction of two conspicuous trenches and a trough, the Japan Trench, the Izu-Ogasawara Trench, and the Sagami

* and **: Abbreviations used in the descriptions of Part 1.

Trough. The mechanical situation around this junction has produced a complicated tectonic structure and evolution history. The importance of the triple junction in tectonics has been only briefly discussed, first by McKenzie and Parker (1967); later, the geometrical relationship to the stability of a triple junction was thoroughly discussed by McKenzie and Morgan (1969) on the simple assumptions of geometrical symmetry of the ridge system and non-deformable character of colliding or spreading plates. They concluded that the triple junction off Japan (model 'a' of TTT, McKenzie and Morgan, 1969) is unstable and the junction will move in such a way that the Sagami Trough and Japan Trench form a straight line, which seems unlikely if one assumes that the Japan Sea has been opening up since the middle Miocene.

Seno *et al.* (1989) discussed the stability of this junction based on their own data (Seno *et al.*, 1988) and data of Ogawa *et al.* (1989), and concluded that retreat of the Philippine Sea Plate relative to the Pacific Plate toward N58°W makes the triple junction stable. Their model includes stretching of the upper part of the lithosphere (stretched basin model; Seno *et al.* 1989) produced by blocking or logging of the Pacific Plate, subducting underneath the North American Plate, behind the retreating Philippine Sea Plate.

Kinoshita *et al.* (1986) constructed a model of the crustal structure around this junction, based on geophysical data obtained by Kaiko I Research Group (1986), which included a mechanism for earthquakes of intermediate depth. They suggested that stretching of the Philippine Sea Plate may have occurred due to steepening of the subduction angle of the Pacific Plate toward the south from the junction area. However, Huchon and Labaume (1989) showed, based on the mechanism of a much larger number of earthquakes in the area, that Kinoshita *et al.*'s interpretation (1986) is partly in contradiction with the focal mechanisms which they did not use. Huchon and Labaume (1989) interpreted the stretching as due to three dimensional distortion of the Philippine Sea Plate colliding with the subducting Pacific Plate deep beneath the Kanto Plain. This process has long been studied by a number of researchers (e.g., Ishida, 1986). Tomoda and Iwasaki (private communication) and Iwasaki (1984) interpreted the deepening of the triple junction bathymetry based on the gravimetric anomaly from this area as due to gravitational instability associated with buckling and consecutive folding of a semi-spherically formed Pacific Plate subducting beneath this area. All these discussions have suffered from lack of information on the structure of the deeper part of the crust and upper part of the lithosphere in this area.

Therefore, the trench-trench-trench triple junction and its western branch (the Sagami Trough), which lies between the triple junction and the mother port of the research vessel, were chosen for the 1989 experiments described here.

In mid-summer of 1989, as part of the Japanese DELP Research Program (DELP: Dynamics and Evolution of Lithosphere Program), a research cruise was conducted in the triple junction area and its western branch (Fig. 1). The main program of this cruise was concentrated on the seismic structural survey and geomagnetic measurements (spatial variations of the total force as well as three components of the local geomagnetic field) in the triple junction area, and heat flow measurements in the western extention of the Sagami Trough from the triple junction. A series of land stations for observing

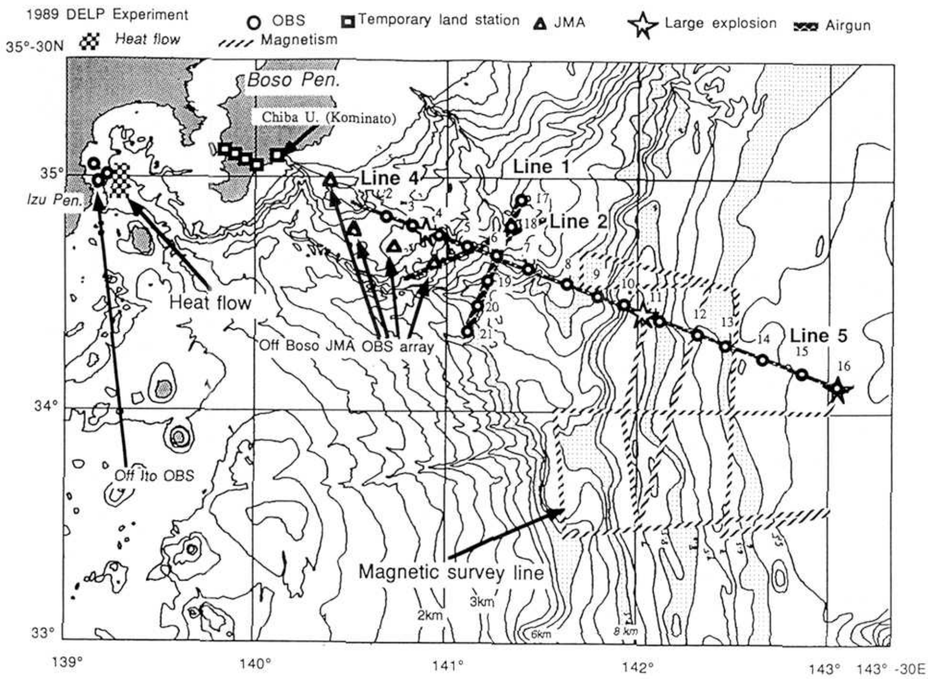

Fig. 1 A sketch map of the survey areas, heat flow stations, monitoring stations for volcanic eruptions, and approximate track lines for seismic structural studies for the DELP 1989 cruise to the trench-trench-trench triple junction and its western extension off the coast of Japan. Brief explanations for each symbol and mark are given in the figure. Survey line A of Figure 3 is divided into parts 4 and 5 in this figure for further use in Figure 4. Line 1 is identical to line B of Figure 3. Line 2 is set only for the multichannel seismic survey in the present experiment. Numbers of OBS (solid open circles) are referred to in Figures 3, 5, 6 and 7.

seismic signals from large volume dynamite shots in the seawater of the triple junction area was established along a line at the southern tip of the Boso Peninsula (Hirata *et al.*, 1990). Four sets of deep sea seismic stations of the Japan Meteorological Agency (JMA), cable-connected to the monitoring land station at Katsuura, Chiba Prefecture, off the east coast of the Boso Peninsula (Fujisawa *et al.*, 1986/ Mori, 1990), were used to monitor seismic signals from the dynamite charges. We also developed a new type of OBS which can stand water pressure as deep as 9000 meters (VD-OBS: Very Deep OBS) particularly for the present study in the triple junction (Fig. 2). The deepest part of the junction bathymetry is about 9260 meters below sea level at 33°30'N, 142°10'E. More details are given in Part 2 (Hirata *et al.*).

The ship used for the 1989 cruise is Dai-5 Kaiko-Maru, chartered from Tokai Salvage Company. Scientists from seven universities and institutions participated in the program. Prior to the present operation, Seabeam mapping and multichannel seismic reflection records of the trough area were released from Hydrographic Department, Maritime Safety Agency (Hydrographic Department, 1982; Kato *et al.*, 1985; Iwabuchi *et al.*, 1990; Kato, 1991) and with additional geophysical data also by Ocean Research Institute, University of Tokyo and others (Kaiko I Research Group, 1986; KH86-5 Cruise, e.g. Seno *et al.*, 1988) which helped greatly in successful conduction of the present program. Immediately before the departure of the research vessel for the first

Fig. 2 A picture of a newly developed VD-OBS. Further details are given in the text.

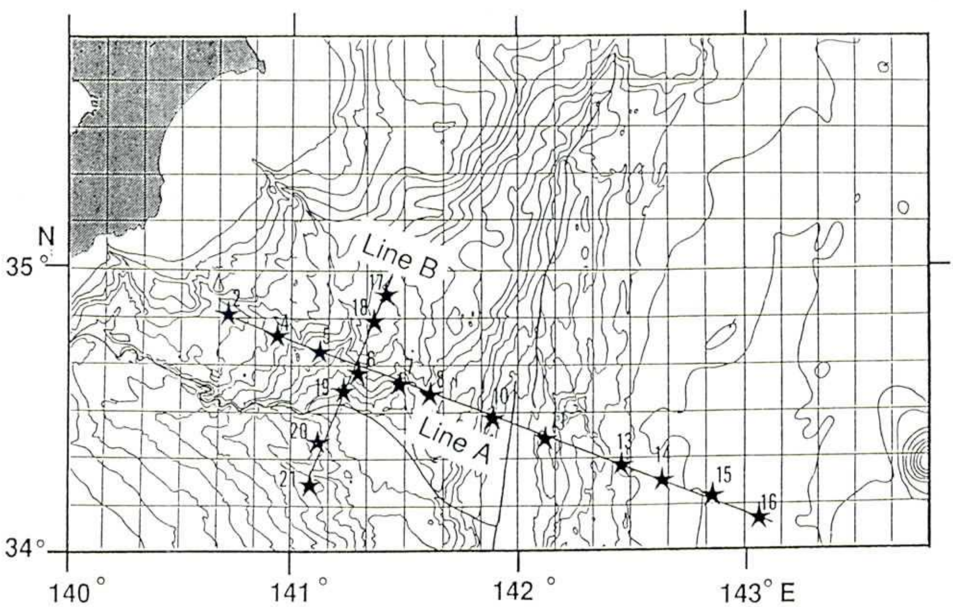

Fig. 3 Positions of OBS seimic stations along two track lines perpendicular to each other used for the DELP 1989 cruise.

survey area, the Sagami Trough, there occurred a number of submarine volcanic eruptions in the western edge of the Sagami Trough (main eruption of the submarine volcano, Teishi Knoll, off the eastern coast of Izu Peninsula on July 15, 1989: Oshima *et al.*, 1990; Watanabe *et al.*, 1991) which is close to the area where had been planning heat flow measurements (Kinoshita *et al.*, 1991). Three sets of the Ocean Bottom Seismographs (OBS) prepared for deployment in the triple junction area after the Sagami Trough expedition were thrown overboard not too close to the center of the tremoring area to monitor the submarine volcanic activity in the area around Teishi Knoll (Kasahara *et al.*, 1991).

Underway geomagnetic and topographic surveys were also carried out on the steaming tracks from port to survey area and on the way back. The survey areas and observation stations of the cruise are given in Figs. 1, 3 and 4.

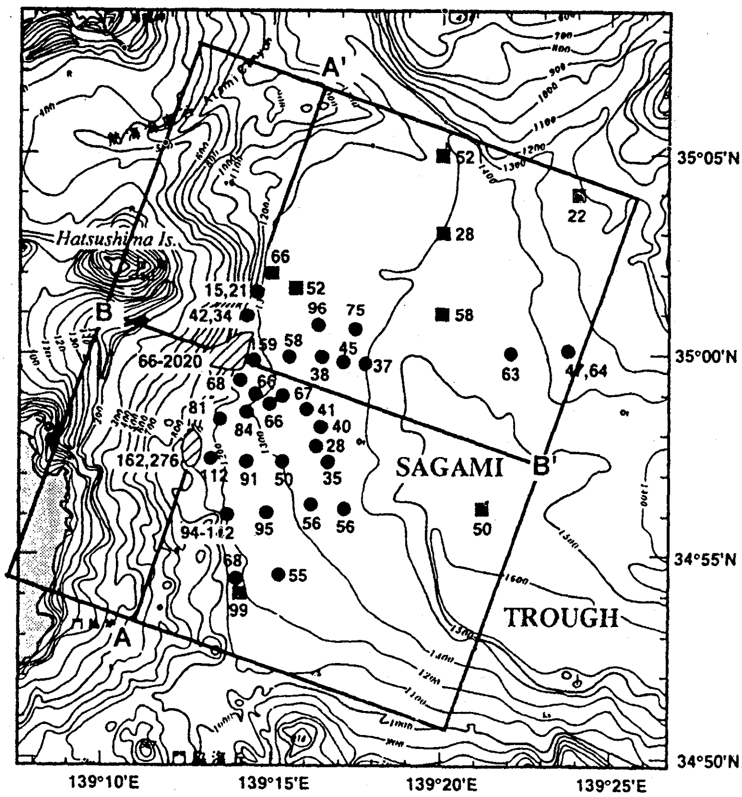

Fig. 4 Positions of heat flow measurements in the Sagami Trough by the DELP 1989 cruise (solid circles) in addition to previous studies (solid squares). Small numbers attached to the spots are heat flow values in mW/m².

2. Cruise Period

July 6, Loading of 6 tons of dynamite and then departure from Toba, Mie Prefecture.

7-10, Deployment of OBS for monitoring submarine volcanic activity and then measurement of heat flow in the Sagami Trough area.

14, Port call at Shimoda, Shizuoka Prefecture to replace scientists.

14–22, Magnetic measurements, single channel seismic reflection measurements, deployment of OBS and VD-OBS. Explosion of small dynamite charges and Airgun shooting against submarine off-line and on-line OBS and off-line land OBS. Explosion of large volume dynamite charges.

23, Return to mother port of the research vessel (Toba). Proton procession and three-component magnetic measurements were run all along steaming tracks.

3. Items of Observation

1) 12 KHz precision depth recording.
2) 3.5 KHz depth recording.
3) Single-channel seismic profiling.
4) OBS (29 sets) and land stations (5 sets)
   Of 29 sets of OBSs, 22: ordinary OBS, 3: VD-OBS, 4: cable-connected JMA OBS.
   4)-1 Crustal and upper mantle structure.
   4)-2 Natural seismicity.
   4)-3 Submarine volcanic activity.
5) Marine geomagnetic survey.
   5)-1 Total force distribution.
   5)-2 Three component orientation.
6) Heat flow; using pogo and single penetration.

4. Data Filing and Processing

1) Track positioning.
2) Depth record (digitized) for entire track lines.
3) Shot using large volume airgun.
4) Shot using dynamite explosions.
5) Geomagnetic elements (Hx, Hy, Hz and F).
6) Seismic waveform (digitized).

5. Participants

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6. Main Operations

Marine geophysical surveys of the DELP 1989 cruise were concentrated mainly on heat flow and volcanic activity measurements in the western corner of the Sagami Trough and on studying the seismic structure and magnetic lineation in the triple junction area. The heat flow measurements in the Sagami Trough had been made only at a limited number of stations (Watanabe, 1972; Fujiwara, 1985) until the present study, although this part of the collision and subduction scheme between the Philippine Sea Plate and the North American Plate needed studies based on a much larger number of heat flow measurements (Fig. 4). A detailed description of the heat flow measurements of this cruise is presented in Part 4 of this issue. The seismicity survey was to determine the cause of the recent volcano-seismic activity of Teishi Knoll, which started right before the departure of our research vessel, and to clarify the seismic crustal structure in its immediate area (Kasahara *et al.*, 1991).

The Seismic crustal structure of the triple junction area has long remained unknown to us although there have been a number of structural models (Kinoshita *et al.*, 1986; Huchon and Labaume, 1989; Seno *et al.*, 1989; Ogawa *et al.*, 1989) based on bathymetric topography; and measurements of the magnetic and gravity anomaly distribution around this area (Hydrographic Department, Maritime Safety Agency, 1982; Nishimura *et al.*, 1984; Kaiko I Research Group, 1986; Nakamura *et al.*, 1987; Renard *et al.*, 1987). A seismic survey of the upper part of the lithosphere around the triple junction was conducted by use of single channel seismic reflection as well as the refraction method using OBS, with large volume airguns and dynamite charges as controlled sound sources. Three sets of OBS designed for very deep water (6000–9000 meters) were utilized in the present experiment (acronym; VD-OBS after Kanazawa and Kaiho, 1990). Geomagnetic surveys were run along the entire track line by use of both three-axis and proton precession magnetometers. Positions of the observation stations and other basic data of these operations are presented in this part. More detailed descriptions of individual operations are presented separately in other parts of this issue.

6-1. Seismic Experiments with Controlled Sound Sources

Single channel seismic reflection profiles were obtained using a digital converter and hard disk attached to a desk-top micro-computer as a data logger along line A of the two main OBS track lines which run perpendicular to each other, one of them over near the deepest part of the triple junction (Figs. 1 and 3). Twenty two sets of OBS were deployed along the track lines by cooperation among the Earthquake Research Institute, and Department of Geophysics (presently; Department of Earth and Planetary Physics), University of Tokyo; Observation Center for Prediction of Earthquakes and Volcanic Eruptions, Tohoku University; Department of Earth Sciences, Chiba University, and Department of Marine Mineral Resources, Tokai University. Positions and water depths of the OBS stations are listed in Part 2 (Hirata *et al.*) of this issue. The survey line was about 300km long. Large and small charge explosives and airgun shootings were conducted along the track lines. The positions of the stations for large volume explosions are listed in Table 1. Distribution of the OBS stations is shown in Fig. 3 and listed in Part 2 of this issue. Original record sections of arrival time versus distance for individual OBS's for structural analyses are illustrated in part 2 (Hirata *et al.*) of this issue.

More detailed analysis of the explosion seismology has been done by Kaiho (Ph.D. Thesis, and private communication, 1992). These results are presented in the following section.

6-2. Heat Flow Measurements

The western corner of Sagami Trough was chosen for concentrated heat flow measurements. Measurements were made mostly by ordinary marine heat flow meters (p.555 of Kinoshita, 1991). The heat flow station positions are shown in Fig. 4; more details and some interpretation of the heat flow anomalies are discussed in Part 4 (Kinsohita *et al.*) of this issue, and by Kinoshita *et al.* (1991).

6-3. Marine Geomagnetic Surveys

At three-component magnetometer on board and proton precession magnetometer towed behind the vessel were run through the entire period of the cruise. An onboard magnetometer system had to be calibrated as many times as possible when the ship changed its latitude. It was assumed that there is a considerable change in magnetic field elements with latitude, and both induced and remanent magnetiziations of the research vessel made of steel are affected by sailing. The calibration was done by turning the vessels bearing around smoothly by 360 degrees, and twice in the opposite sense. Detailed surveys were made at the deepest part of the triple junction area. Detailed descriptions of the magnetic operations are given in Part 3 (Isezaki *et al.*) of this issue.

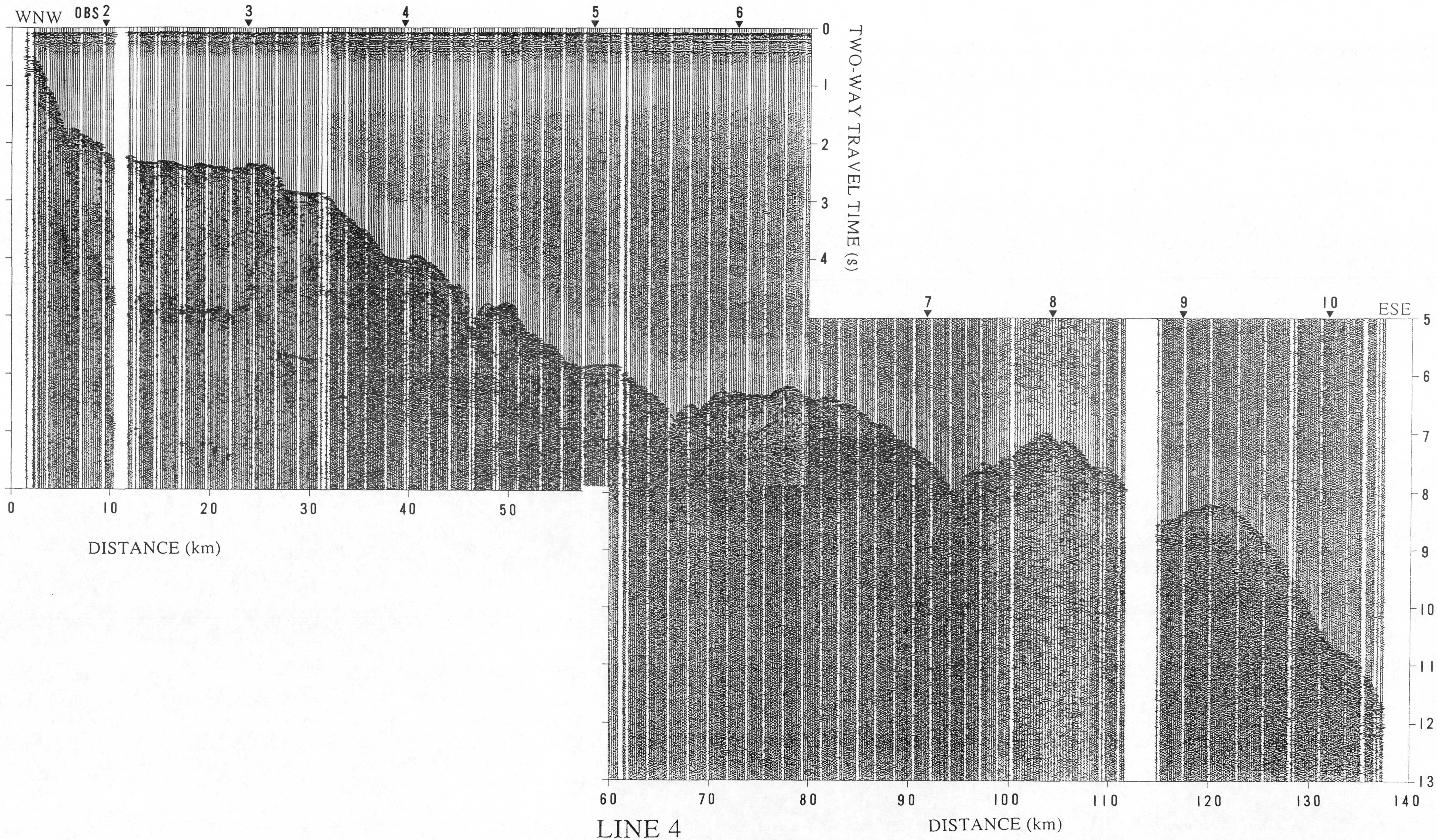

Fig. 5 Image of seismic reflection profiling along one of the OBS track lines (lines 4 and 5 in Fig. 1) across the depression of the triple junction axis. (1) for line 4 and (2) for line 5. There are normal faults in the sedimentary layer on the eastern flank of the Izu-Ogasawara Trench in contrast to a mixture of normal and reverse faults on its western flank.

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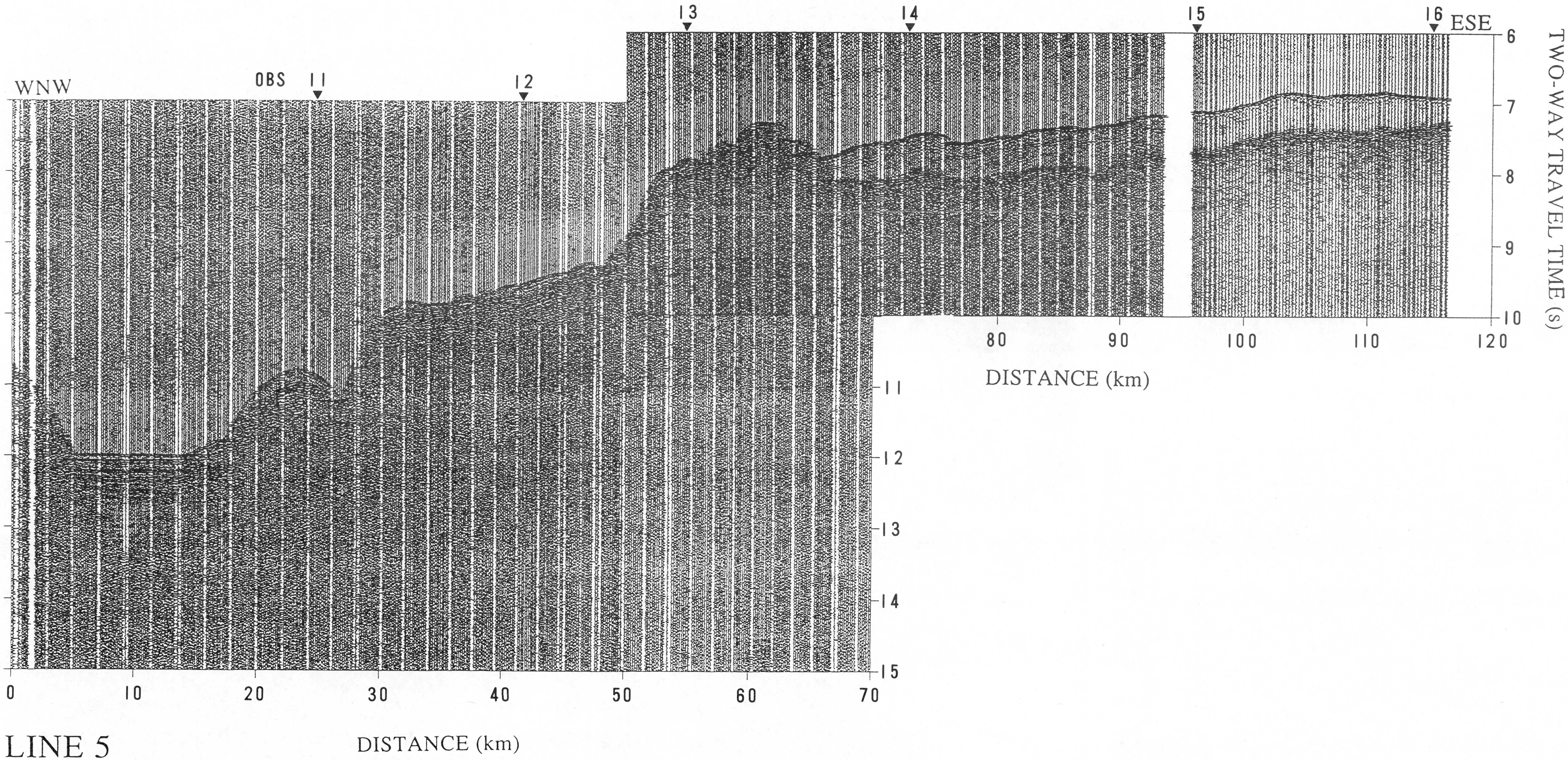

LINE 5

Table 1. Geographic coordinates and water depths of the position of dynamite shot stations. From right to left: Number of station, Latitude (two columns), Longitude (two columns), time (three columns (day: hour: minute:) second down to three decimal figures) and water depth. Water depths of stations were obtained from a bathymetric map issued by the Hydrographic Department, Maritime Safety Agency (1982), due to occasional malfunctioning of the Precision Depth Recording system of the research vessel during the operation.

Table : DynamiteShotData 2-AUG-91 23:45:46
* base day:7/15, 0:00 437 msec delay, rate: -0.134616(adv) msec/hour vs.
* master clock.(tcg-master: -1486,-3.03462/h 1991 7 6

No.	Lat. (Deg.N)		Long.(Deg. E)		day	Hour	Min.	Sec.	Water Depth(m)
1	34	6.76	143	3.87	16	12	30	.945	5190
2	34	7.56	143	2.14	16	13	21	.864	5170
3	34	8.26	143	.01	16	13	38	31.141	5150
4	34	8.82	142	58.09	16	13	54	1.055	5160
5	34	9.44	142	56.12	16	14	9	1.283	5190
6	34	10.02	142	54.20	16	14	23	31.113	5390
7	34	10.62	142	52.19	16	14	39	31.146	5430
8	34	11.24	142	50.34	16	14	55	.973	5470
9	34	11.81	142	48.35	16	15	10	31.062	5510
10	34	12.36	142	46.25	16	15	27	1.107	5490
11	34	13.02	142	44.36	16	15	42	.874	5550
12	34	13.58	142	42.50	16	15	56	31.081	5560
13	34	14.17	142	40.63	16	16	11	31.160	5400
14	34	14.75	142	38.69	16	16	27	.759	5995
15	34	15.36	142	36.73	16	16	43	.781	6070
75	34	50.96	140	40.18	17	5	11	20.733	1650
74	34	50.36	140	42.21	17	5	29	.675	1740
73	34	49.71	140	44.27	17	5	47	30.786	1790
72	34	49.19	140	46.18	17	7	14	30.588	1930
71	34	48.52	140	48.09	17	7	32	30.538	2090
70	34	47.96	140	49.92	17	7	46	30.427	2170
69	34	47.46	140	51.80	17	8	1	30.671	2270
68	34	46.77	140	53.85	17	8	17	.463	2730
67	34	46.19	140	55.78	17	8	31	30.669	3020
66	34	45.66	140	57.86	17	9	42	.191	3200
65	34	45.06	140	59.53	17	12	39	30.524	3450
64	34	44.48	141	1.55	17	12	56	30.475	3450
63	34	43.89	141	3.59	17	13	13	30.695	4120
62	34	43.27	141	5.40	17	13	29	30.508	4330
61	34	42.69	141	7.34	17	13	46	.302	4400
60	34	42.10	141	9.58	17	14	2	30.519	4520
59	34	41.55	141	11.29	17	14	19	.437	4900
58	34	40.92	141	13.22	17	14	35	.199	5150
57	34	40.36	141	15.16	17	14	50	30.372	4010
56	34	39.77	141	17.06	17	15	7	.296	4370
55	34	39.18	141	19.02	17	15	23	30.534	4520
54	34	38.54	141	21.14	17	15	40	30.401	4840
53	34	37.98	141	22.87	17	15	55	.312	5290
52	34	37.34	141	24.98	17	16	11	.565	5630
51	34	36.76	141	26.88	17	16	26	.154	5830
50	34	36.19	141	28.81	17	16	42	.181	6250
49	34	35.63	141	30.72	17	16	58	.174	6950
48	34	35.01	141	32.67	17	17	14	30.420	7270
47	34	34.41	141	34.69	17	17	31	30.586	7570
46	34	33.79	141	36.65	17	17	48	30.366	7580
45	34	33.21	141	38.52	17	18	3	30.318	7550
44	34	32.65	141	40.45	17	18	19	1.090	7420
43	34	32.09	141	42.41	17	18	33	30.719	6460
42	34	31.47	141	44.33	17	18	48	.129	6300
41	34	30.89	141	46.38	18	5	57	29.956	6410
40	34	30.28	141	48.25	18	6	10	30.083	6740
39	34	29.69	141	50.24	18	6	38	30.282	7510
38	34	29.13	141	52.10	18	6	52	29.813	8180
37	34	28.52	141	54.08	18	7	6	29.717	8610
36	34	27.93	141	56.00	18	7	56	29.709	9200
35	34	27.35	141	57.97	18	8	11	59.620	9200
34	34	26.72	142	.02	18	8	27	29.850	9200
33	34	26.13	142	1.95	18	8	42	58.908	9200
32	34	25.52	142	4.19	18	10	7	59.821	9010
31	34	25.03	142	5.66	18	10	45	29.693	8600
30	34	24.39	142	7.64	18	11	4	29.728	8330
29	34	23.76	142	9.76	18	11	20	29.641	8600
28	34	23.23	142	11.65	18	12	47	30.490	8000
27	34	22.61	142	13.54	18	13	3	29.686	7540
26	34	22.00	142	15.62	18	13	19	29.621	7480
25	34	21.45	142	17.47	18	13	35	1.055	7350
24	34	20.81	142	19.47	18	13	50	31.005	7220
23	34	20.26	142	21.38	18	14	5	1.025	7110
22	34	19.66	142	23.31	18	14	20	31.026	6880
21	34	19.07	142	25.21	18	14	35	30.836	6500
20	34	18.46	142	27.19	18	14	51	1.374	6070
19	34	17.93	142	29.13	18	15	17	30.880	5750
18	34	17.27	142	31.11	18	15	32	31.008	5570
17	34	16.67	142	33.01	18	15	47	.792	5760
16	34	16.13	142	34.95	18	16	1	31.216	5820

7. Results

1) Digital single channel seismic profiling revealed the seismic structure of the upper part of the crust of the triple junction area (Fig. 5), its general features are consistent with the interpretation of the multichannel seismic reflection survey achieved by Iwabuchi *et al.* (1990). These observations show that there are normal faults in the sedimentary layers on the eastern flank of the Izu-Ogasawara Trench, which the triple junction belongs to, suggesting an E-W extensional stress state. In contrast, there is a mixture of normal and reverse faults in the sediment cover on the western flank, indicating imbrication of the upper part of the subducting Pacific lithosphere as well as slumping at the land mass into

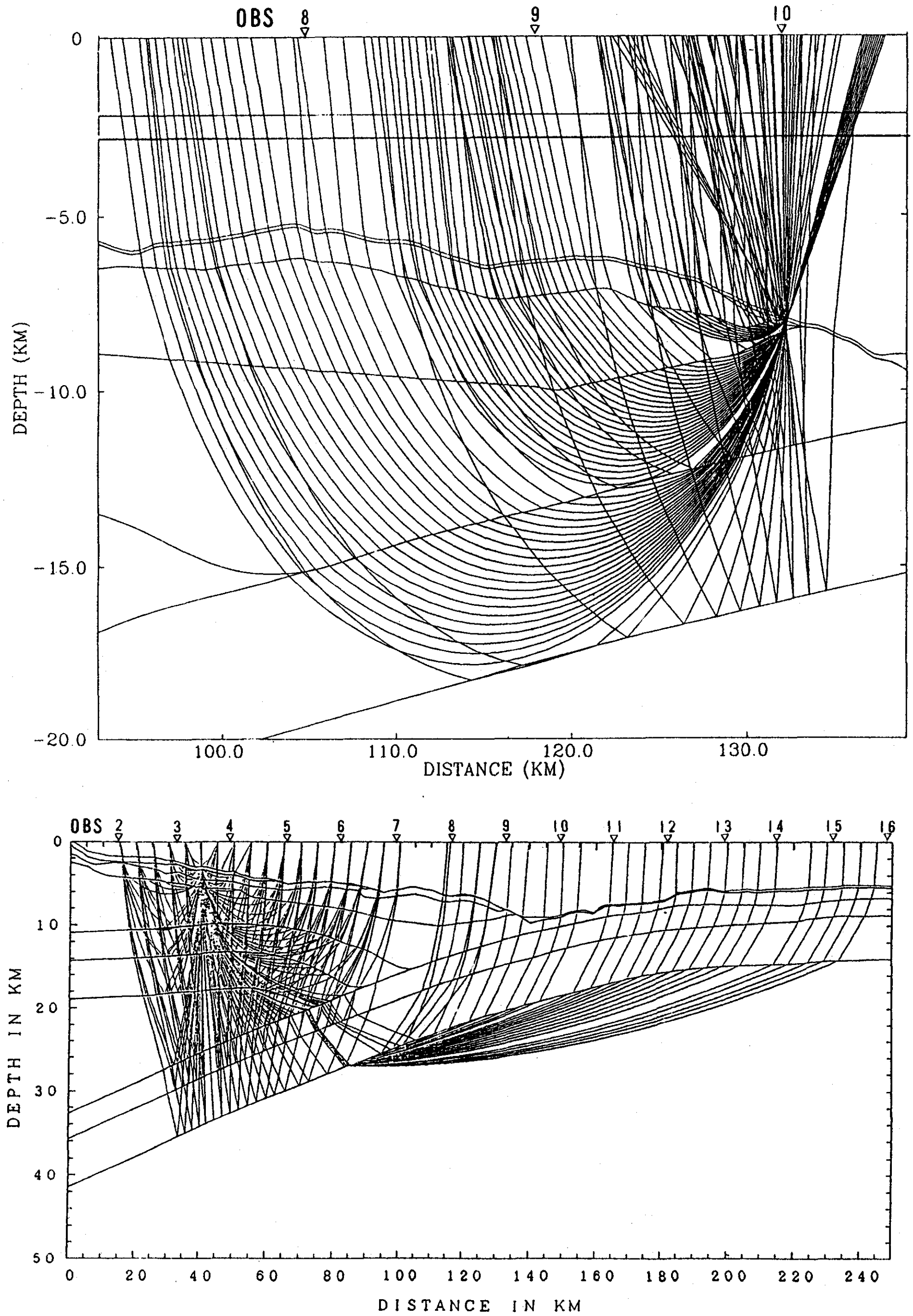

Fig. 6 Examples of data processing for obtaining seismic structure along track line A of Figure 3 by use of a ray tracing procedure. (1) from OBS data on the continental slope of the triple junction and (2) from a continental shelf station nearer to the Kanto Plain.

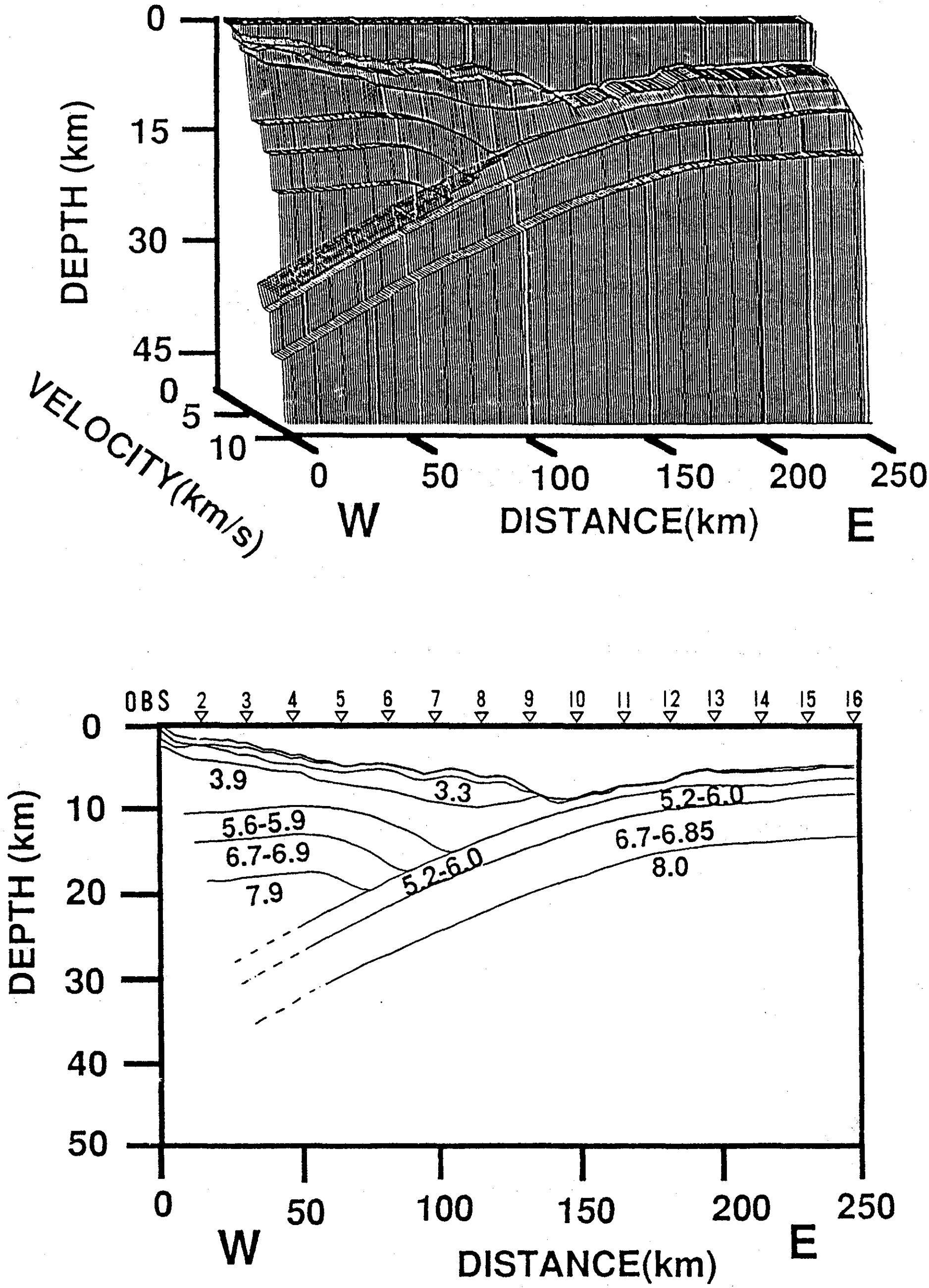

Fig. 7 Seismic velocity structure along track line A of Fig. 3. The top figure shows the velocity structure in three dimensions: Depth, Distance and Velocity. The bottom figure shows a two-dimensional cross section of the velocity structure along the track line.

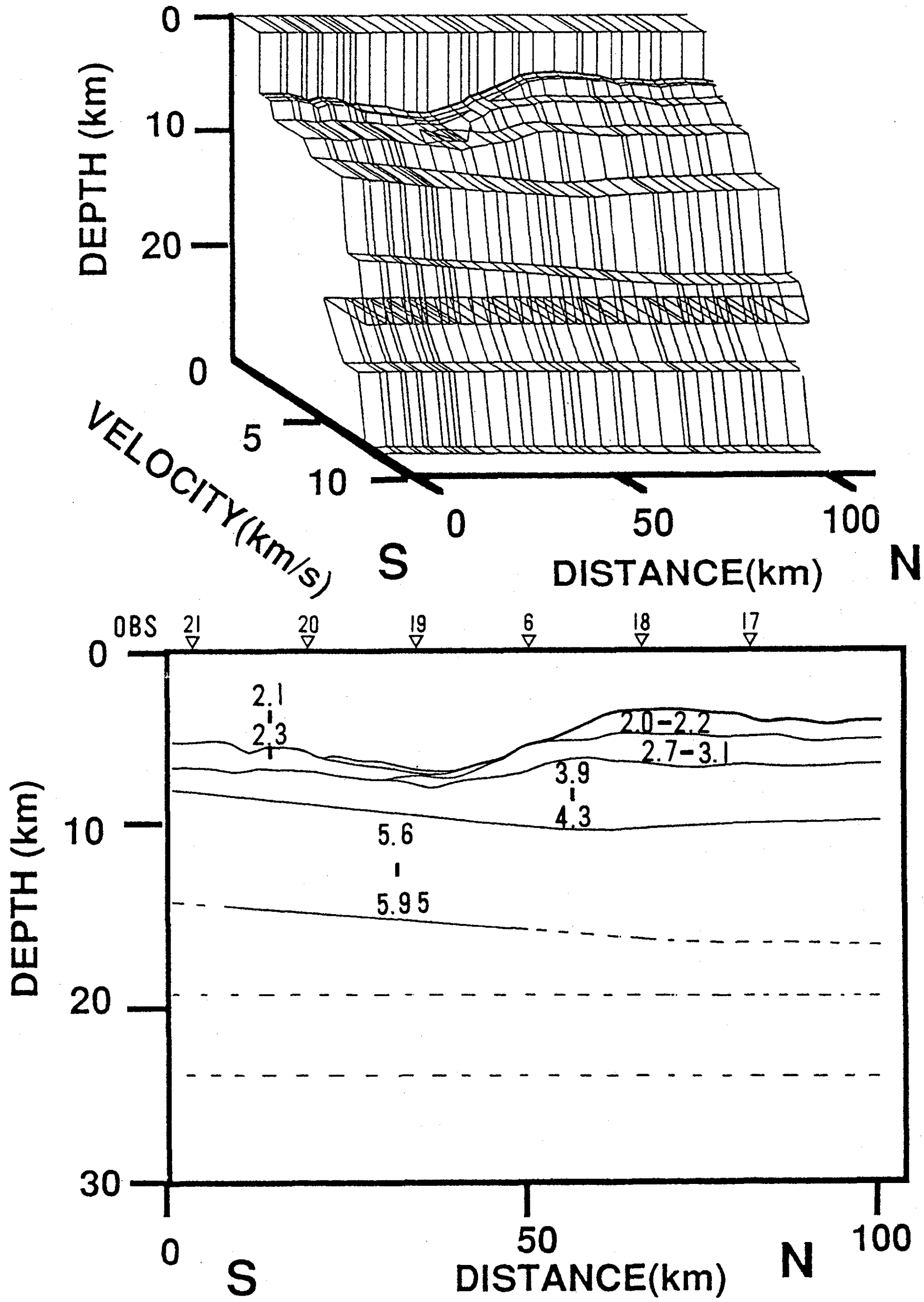

Fig. 8 Same as in Fig. 7 along track line B of Fig. 3.

the deeper part of the trench.

2) The seismic structure of the deeper part of the crust and upper mantle of the triple junction area was constructed (Fig. 6) by using the two-dimensional ray tracing method (details are given in Part 2 by Hirata *et al.*) along two track lines (Figs. 1 and 3), a N-S trending, relatively short line and an E-W trending longer line. It is well understood, therefore, that the modelling along the E-W line is much easier and probably more accurate than that along the N-S line. The final models of the seismic velocity structure along the two lines are given in Figs. 7 and 8. These velocity values are presently reinvestigated, and therefore there might be a slight change in P-wave velocity values in the future. From these figures we find following new facts assuming that the typical oceanic plate consists of basaltic, gabbroic and peridotitic layers, and some sedimentary layer(s) overlying them. It is shown definitely that the three Plates indeed meet in the survey area. We believe, for the reasons noted in Part 2 (Hirata *et al.*, this issue) based

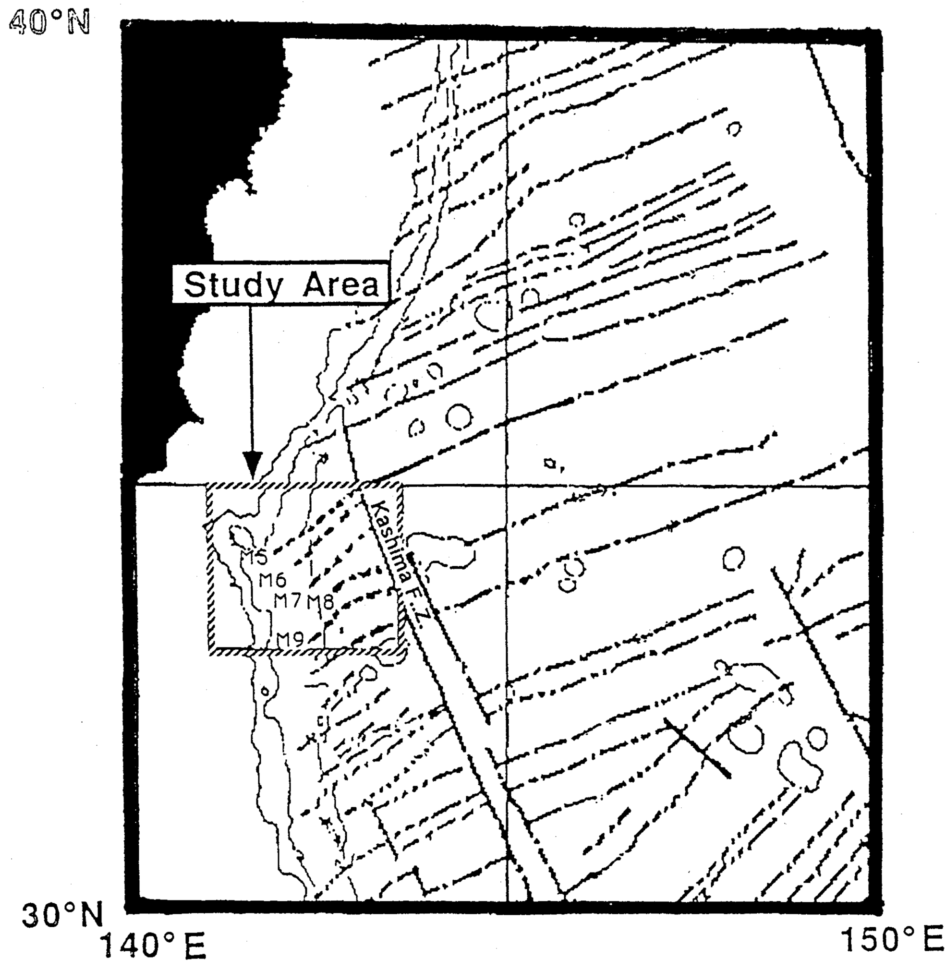

Fig. 9 Geomagnetic anomaly lineations in the vicinity of the present survey area. More details are given in Part 3 by Isezaki *et al.*, this issue.

on Fig. 7 (E-W line), that the Pacific Plate lies beneath the Philippine Sea Plate while the latter lies underneath the North American Plate in Fig. 8 (N-S line). There is no clear evidence of stretching or thinning of the North American or Philippine Sea Plates from the present seismic structure as inferred by Kinoshita *et al.* (1986) or suggested by Seno *et al.* (1989). This does not mean, however, that there is no stretching portion somewhere around the triple junction area, for the present study has been performed only along two descrete track lines away from the place that Seno *et al.* (1989) referred to. In addition, the western side of the E-W line shows slight distortion of the lithosphere between the upper sedimentary section and the bottom Pacific Plate, similar to the possible bending of Philippine Sea Plate suggested by Ishida (1986).

3) Magnetic lineation patterns as identified in this area are as old as M5 (ca 118 Ma) as opposed to the widely accepted view that there should be lineament as old as M9 (122 Ma) in the present area (Nakanishi *et al.*, 1989). The lineaments in the triple junction area seem to be distorted and have likely been rotated by 25 degrees counterclockwise. In comparison with those* in the western corner of the Pacific Plate to the east of the triple junction beyond the Kashima fracture Zone (Fig. 9 and Part 3 by Isezaki *et al.*, this issue).

4) Some kind of hydrothermal venting along a linear line near the eastern coast of the Izu Peninsula, where the Philippine Sea Plate and the North American Plate are colliding, were found (submersible dive and others; details are referred to in Part 4, this issue) along a line of anomalously high heat flow values (Fig. 4 and Part 4 by Kinoshita *et al.*, this issue).

5) A new type of OBS (VD-OBS), which resists much greater depths (9000 meters) compared to those (6000 meters) constructed so far, was tested for the first time in the field. This system has worked well, although a number of parts had to be replaced or refined. All parts, i.e., pop-up system, radio beacon, flashing light, acoustic transmitter, and mechanical release, designed to stand 9000 meter seawater pressure, were found to be basically good, but there was poor bouyancy balance when the instrument floated on the sea surface, which might cause a loss of equipment due to sinking of positioning devices for recovery.

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1989年度 DELP 海溝三重会合点海域調査研究航海報告
第一部：概要

DELP 背弧海盆研究班
及び
DELP リソスフェア深部構造研究班

この報告では主として1989年度 DELP 計画による DELP－89 研究航海の成果を記述する．この航海目的は1984年度頃より得られた詳細な海底地形及び地磁気・重力探査等の調査結果の成果などから得られた，地震構造，海上地磁気異常，海底地殻熱流量の測定値分布などの結果を総合して，この地域のプレート衝突境界の状況をより明確にしようとするものである．この部分（Part 1）では1989年度 DELP 研究航海計画の目的，航海海域及び測線・測点，航海期間，観測項目，データ整理方法等について記述する．最後に今日までに得られた成果を参照してテクトニクス的議論を行う．なお地震探査，地磁気探査，地殻熱流量探査の各項目についてはそれぞれ Part 2–4 で詳述される．