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Report on DELP 1988 Cruises in the Okinawa Trough Part 2. Seismic Reflection Studies in the Southwestern Part of the Okinawa Trough

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Abstract

Multi- and single-channel seismic reflection profiles along four track lines in the southwestern part of the Okinawa Trough were obtained during the 1988 DELP cruise. The trough is a back-arc depression located between the Ryuku Arc and the shallow shelf of the East China Sea. The acoustic sequence in the trough can be divided into three units depending mainly on the varying degrees of deformation and reflection character. Widespread deformation by normal faulting is especially developed in the lowest unit which displays horst and graben structures. The deformation would have originated at about the Plio-Pleistocene boundary and formed the prototype of the trough. Reflectors observed within the upper unit show the tilting and subsidence of the trough floor, and essentially no deformation by faulting except for the Yaeyama Graben area located in the axial part of the trough. Just along the Yaeyama Graben, rifting and subsidence with normal faulting are in progress. Some volcanic intrusions observed in the Yaeyama Graben indiccate that the bimodal and/or island-arc type volcanisms have occurred. These tectonic events suggest that the origin of the trough is the continental rifting and that the trough is in a state of the rifting stage. Also, the events suggest that the back-arc spreading might have recently initiated only in the Yaeyama Graben.

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1. Introduction

The Okinawa Trough is one of the several basins along the margin of the western Pacific and southeast Asia, and is located between the Ryukyu Arc and the shallow shelf of the East China Sea (Fig. 1). Various kinds of studies for the trough have been done by several institutes and many workers. Basement rocks and sediments of the trough, however, remain to be sampled by deep sea drilling.

A regional seismic reflection survey was carried out in 1968 by WAGEMAN et al. (1970). They were the first to establish the structural relationship of the Ryukyu Arc, Okinawa Trough, and the shallow shelf

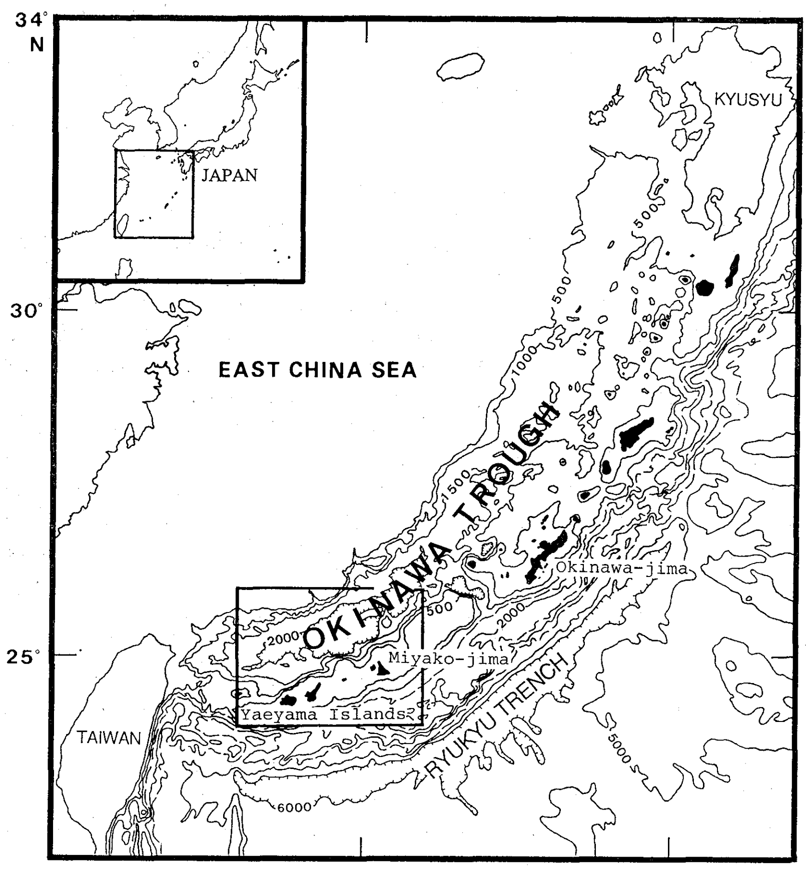

Fig. 1. Topographic map of the Okinawa Trough and its adjacent area. Counters are in meters. Detailed bathymetric chart of the survey area of the 1988 DELP cruise is shown in Figure 2. A solid rectangle in the southwestern part of the Okinawa Trough area denotes the area of Figure 2.

of the East China Sea, and showed that the trough was of fault origin based on their observation that the slopes of the trough were formed by a series of normal faults which were underlain by complex folds and exhibited extensive slumping. Also, they speculated that the trough originated during the Neogene.

Typical grabens of the Okinawa Trough were delineated by HERMAN et al. (1978) from seismic reflection profiles obtained in the southwestern part of the trough. On the basis of evidence from some dredge samples reported by HONZA (1976), active faulting in the grabens, and distribution of unconformity in the sediment layer of the trough, HERMAN et al. (1978) concluded that the southwestern part of the trough was formed by back-arc spreading which initiated some time after the late Miocene to early Pliocene time and the Ryukyu Arc was rifted from the continental margin, shallow shelf of the East China Sea, and that extension is presently confined to a zone narrower than 15 km defined by the two grabens.

After that, KIMURA (1985), LETOUZEY and KIMURA (1985), and LETOUZEY and KIMURA (1986) established detailed structural maps for the whole area of the Okinawa Trough and suggested that the main opening of the trough dates back to the early Pleistocene.

Seismic refraction studies by MURAUCHI et al. (1968) indicated that the crustal velocity beneath the Okinawa Trough is generally similar to that of the continental crust. Also, studies by LEE et al. (1980) confirmed that the velocity structure and crustal thickness of the trough are continental in character except in the southwestern part of the trough. Free air gravity data suggest that the crust has continental density and thicknesses for the whole area of the Okinawa Trough and its adjacent area but also indicate a general thinning of the crust beneath the trough (HONZA, 1976). The above studies were generally regarded as evidence of crustal extension and rifting in the Okinawa Trough.

The purpose of this study is to elucidate detailed seismic stratigraphy and tectonic events in the southwestern part of the Okinawa Trough by using new seismic reflection data obtained during the 1988 DELP cruise. Then in this report we try to describe the formation of the southwestern part of the Okinawa Trough.

The study area includes the trough itself, shallow shelf of the East China Sea, and Ryukyu Arc (Fig. 2). The topography of the area strikes approximately N60°E (Figs. 1 and 2). Three grabens which show an echelon pattern are observed within the trough (Fig. 2).

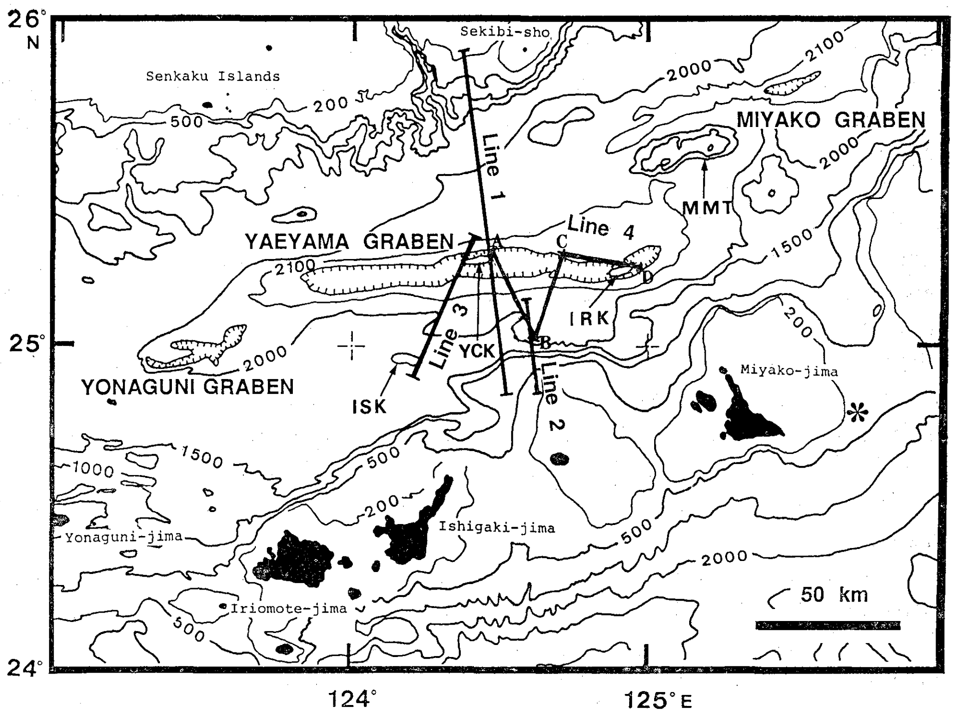

Fig. 2. Track chart for seismic reflection studies of the 1988 DELP cruise in the southwestern part of the Okinawa Trough and its adjacent area. Detailed bathymetric counters are modified from Oshima *et al.* (1988). Counters are in meters. IRK=Irabu sea-knoll. ISK=Ishigaki sea-knoll. MMT=Miyako sea-mount. YCK=Yaeyama central sea-knoll. *=Location of the petroleum exploration well, "Miyakojima-oki" (Tsuburaya and Sato, 1985).

2. Outline of the Survey and Data Processing

The seismic structures of the topmost part of the surveyed area, southwestern part of the Okinawa Trough (Fig. 1), were studied by means of multi-channel and single-channel seismic reflection profiling systems through the 1988 DELP cruise of R/V Dai-5 Kaiko-maru (July 1988). Four continuous track lines were planned in order to cross over the trough. One of the lines, Line 1, crosses the whole trough area from the Ryukyu Arc to the southern margin of the shallow shelf of the East China Sea. Other lines were conducted within the trough floor, especially the Yaeyama Graben elongated along an E-W direction in the axial part of the trough. The track lines of the seismic profiling studies and detailed bathymetric chart of the study area are shown in Figure 2. In the following text all locations of profiles refer to this figure.

Multi-channel seismic (MCS) reflection surveys were carried out by using six channel digital seismic profiling system which is composed of

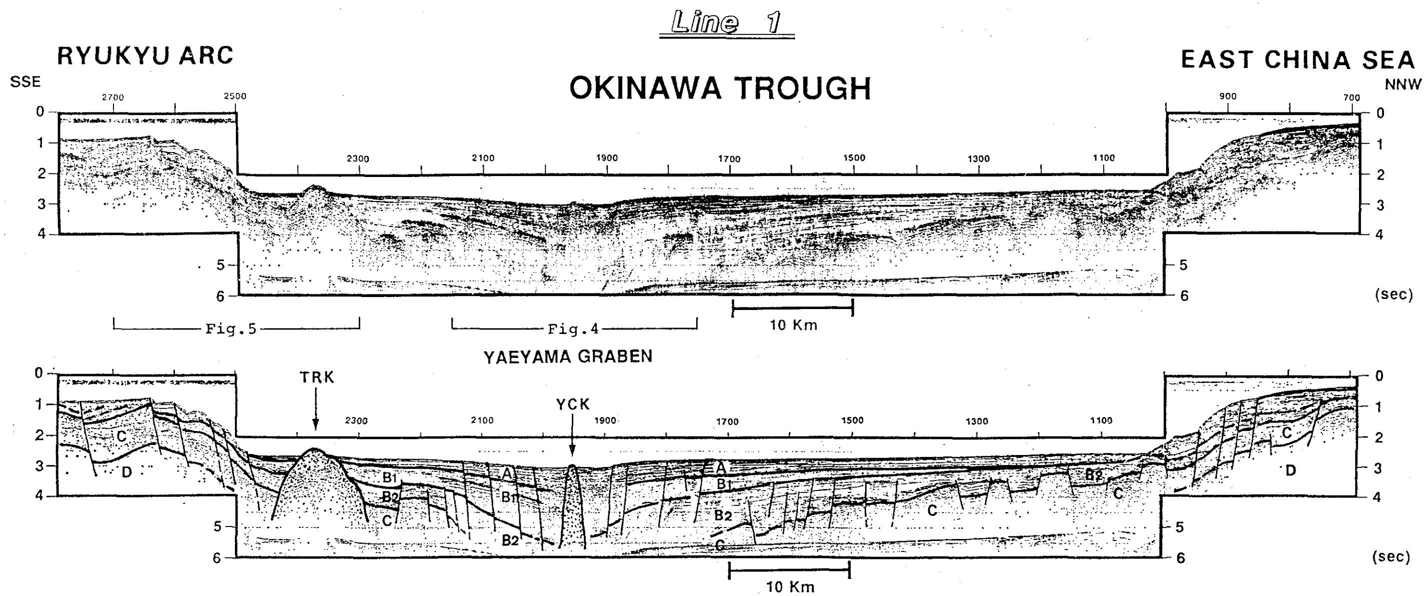

Fig. 3. Multi-channel seismic reflection profile and its interpretation along Line 1 across the whole area of the southwestern part of the Okinawa Trough. Location of the line is shown in Figure 2. The dotted portions on the interpretative profile show the acoustic basements, suggesting that the volcanic intrusions exist. TRK=Tarama sea-knoll. YCK=Yaeyama central sea-knoll.

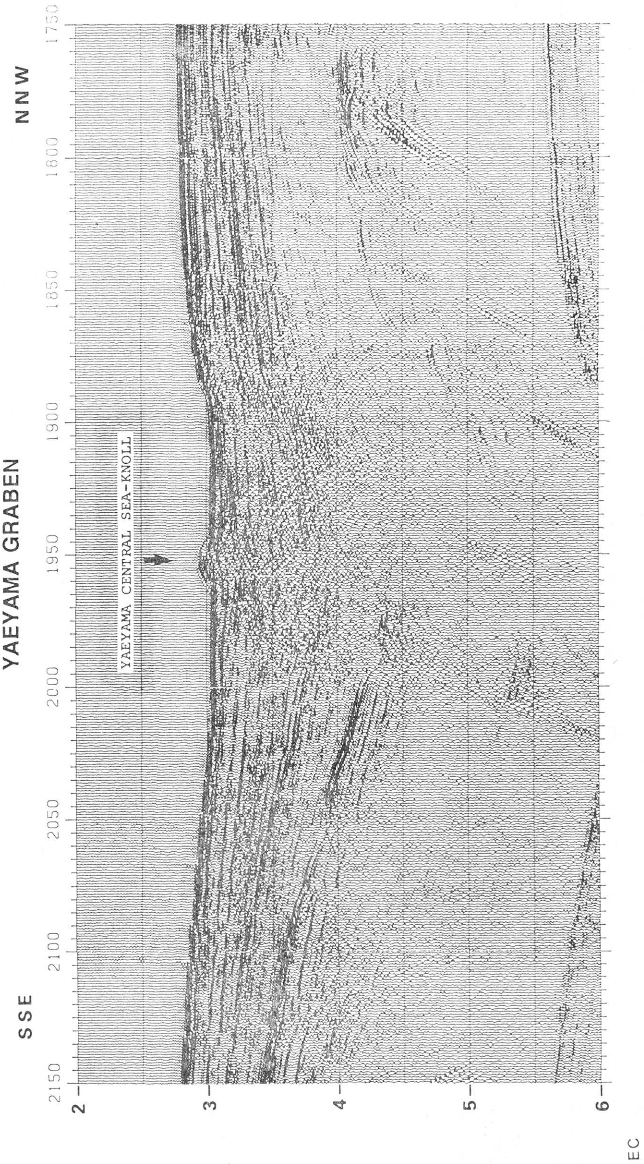

Fig. 4. Multi-channel seismic reflection profile between 1750 and 2150 shot points of Line 1 (Fig. 3).

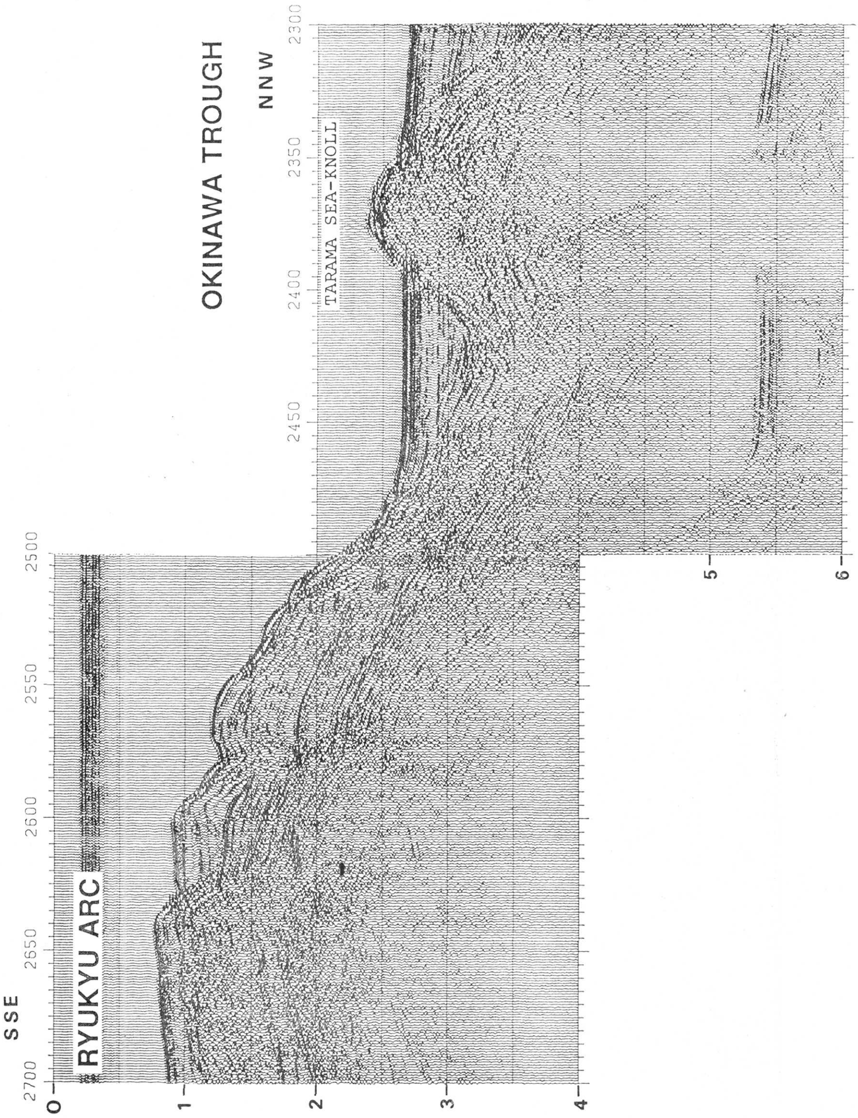

Fig. 5. Multi-channel seismic reflection profile between 2300 and 2700 shot points of Line 1 (Fig. 3).

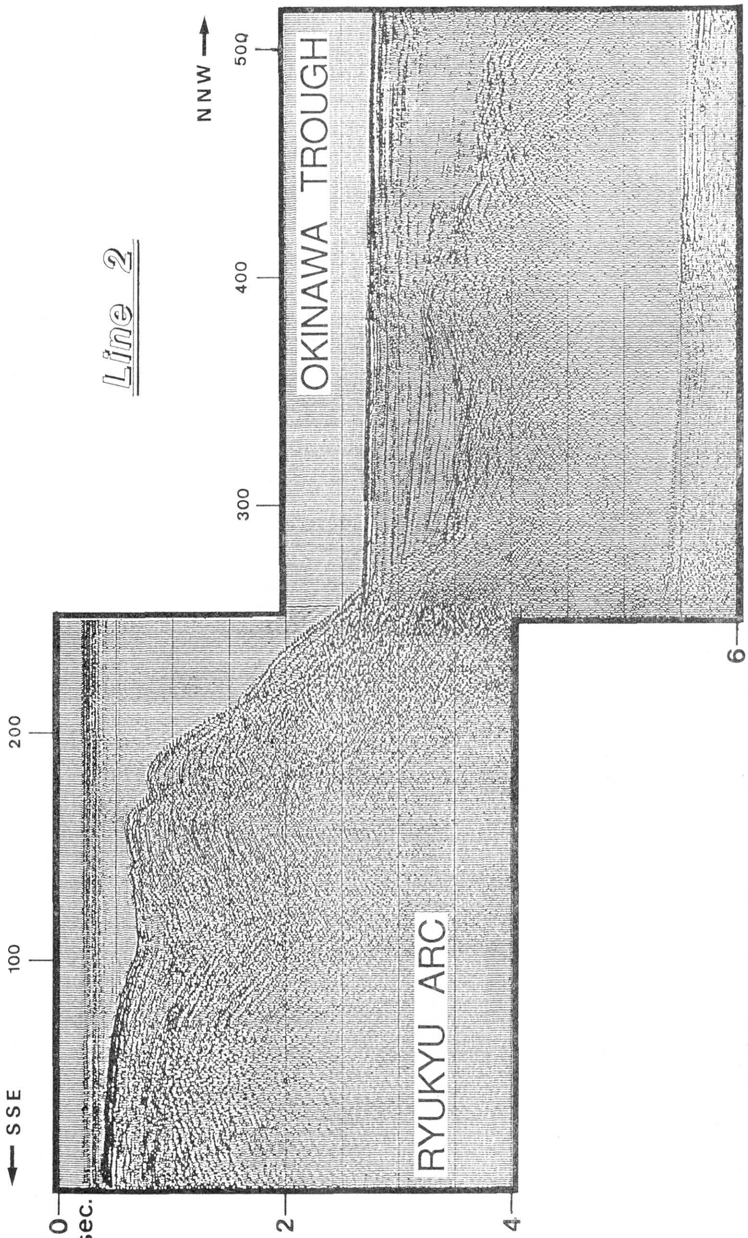

Fig. 6. Multi-channel seismic reflection profile along Line 2. Location of the line is shown in Figure 2.

a hydrophone streamer towed about 300 meters behind the digital data acquisition equipment, and two seismic profiles were obtained along Lines 1 and 2 (Fig. 2). The sound source was an air-gun with a 15 liters firing chamber. The water depth of the shooting was approximately 10 meters and pneumatic pressure of shooting was kept at about 110 atmospheric pressure. During the whole cruise, the air-gun was shot every 20 seconds while the vessel was running straight with a streaming velocity of five knots which means a shot every 50 meters.

The location of the research vessel was mainly obtained by two satellite systems (NNSS and GPS) and occasionally by LORAN-C during the whole cruise, because the survey area in the cruise was too large to be covered by the LORAN-C positioning system.

The MCS profiler data were processed by on-shore studies through staking, filtering, and deconvolution to obtain better refined cross sections. Cross sections of the MCS profiles are shown in Figures 3, 4, and 5 (Line 1) and Figure 6 (Line 2). Figures 4 and 5 are the profiles along a part of Line 1 (Fig. 3). Also single-channel seismic (SCS) reflection profiles are shown in Figures 7 (Line 3) and 8 (Line 4). Here, the vertical scale of the profiles is expressed in two-way acoustic travel time.

During the DELP 1988 cruise a refraction survey was performed by using seventeen ocean bottom seismometers (OBS) deployed along Line 1 (HIRATA et al., 1991; see Part 3 of this report).

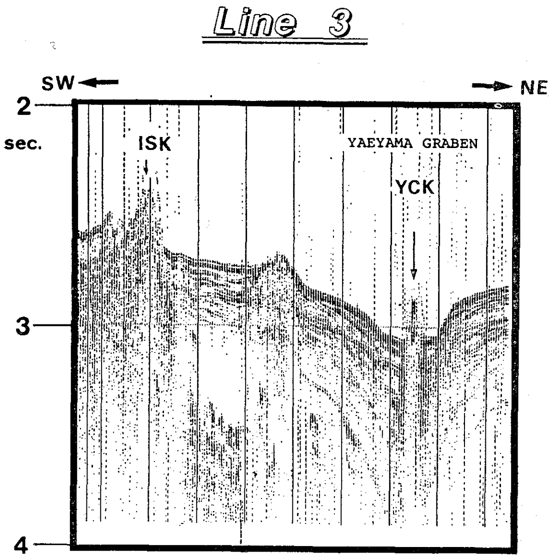

Fig. 7. Single-channel seismic reflection profile along Line 3. Location of the line is shown in Figure 2. ISK=Ishigaki sea-knoll. YCK=Yaeyama central sea-knoll.

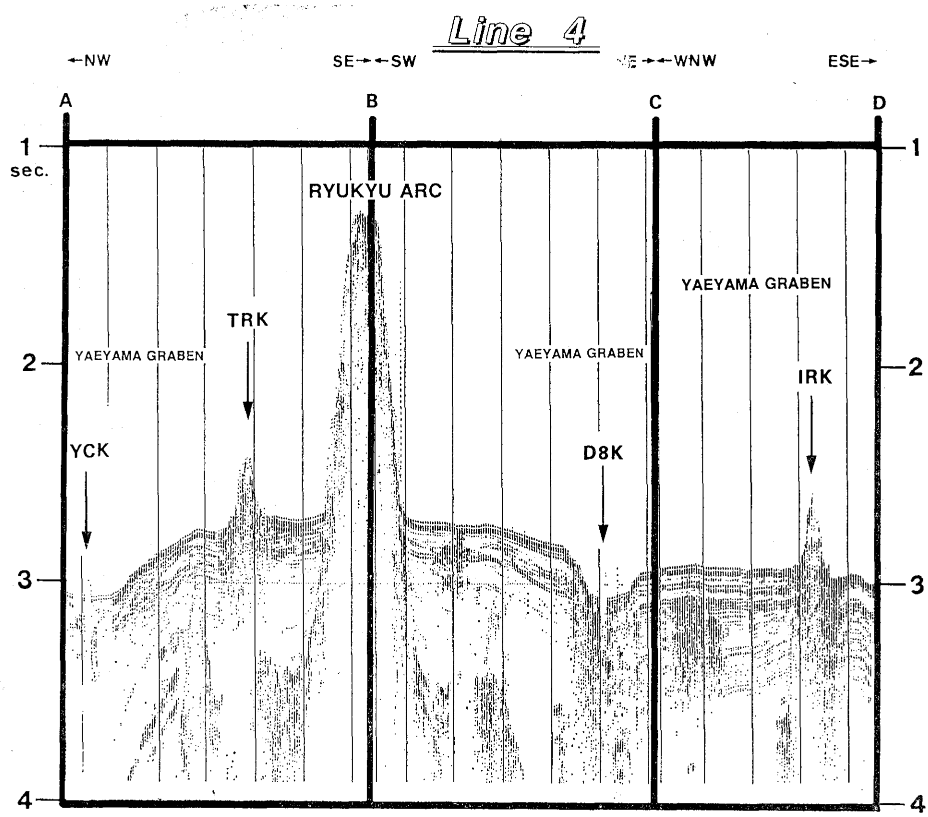

Fig. 8. Single-channel seismic reflection profile along Line 4. Location of the line is shown in Figure 2. D8K=DELF88 sea-knoll (tentative name). IRK= Irabu sea-knoll. TRK=Tarama sea-knoll. YCK=Yaeyama central sea-knoll.

3. Seismic Stratigraphy

The processed MCS reflection profiles (Figs. 3-6) and SCS seismic profiles (Figs. 7 and 8) clearly show a characteristic feature of the southwestern part of the Okinawa Trough. The southwestern part of the trough generally consists of a morphologically flat basin (Figs. 2 and 3), which carries sediments more than 2.5 sec (two-way acoustic travel time) in the axial part of the trough (Figs. 3 and 4). The trough is apparently a depositional basin. Extension and subsidence of the trough floor are recognized on each seismic profile by the downward curvature of reflectors toward the center of the trough and normal faulting within acoustic units (Figs. 3, 4, 6, 7, and 8). For example, the profile of Line 1 (Fig. 3) displays all of these tensional characters. More detailed descriptions about the profiles are given in the following sections.

3-1. Seismic stratigraphy along MCS Line 1

On the basis of interpretation of the seismic profile along Line 1 (Fig. 3), the following features of the trough are observed.

(1) Acoustic sequence in the whole area of the profile is divided into four units which are Units A, B, C, and D in descending stratigraphic order. Here Unit D is an acoustic basement observed only in the Ryukyu Arc and shallow shelf of the East China Sea areas.

(2) In the trough, three acoustic units (Units A, B, and C) are observed, and here Unit C is an acoustic basement. Unit B is distinctly divided into two subunits, an upper Unit B1 and a lower Unit B2, in the trough. Unit A and Unit B can be seen onlap to Unit B and to Unit C respectively on both sides of the trough. Also in Unit B, Unit B1 can be seen onlap to Unit B2.

(3) Unit D subsides toward the trough axis, and disappears beneath the trough floor. Also Unit C subsides as well as Unit D, and disappears beneath the axial part of the trough, the Yaeyama Graben (Fig. 2), at a distance of about 20 km between 1750 and 2150 shot points on the profile (Figs. 3 and 4). Morphology of the Unit C surface displays horst and graben structures by normal faulting in the whole area of the trough floor and both sides of its slopes.

(4) Several normal faults developed within Unit C, especially north side of the trough floor between 1400 and 1700 shot points on the profile, extend to Unit B2. In the both side slopes of the trough, the faults extend to Unit A. These faults, however, generally do not cut Units A and B1 in the trough floor.

(5) In the central portion of the trough between 1750 and 2150 shot points on the profile (Figs. 3 and 4), several normal faults can be seen to have cut the topmost sediment of Unit A. Distribution of these faults coincides with the area where the basement (Unit C) disappears on the profile. The Yaeyama Graben is formed by these normal faulting. The northern wall of the graben is steeper than the southern one (Figs. 3 and 4).

(6) Distribution of the normal faults developed within the acoustic units indicates that the reach of faulting has been narrowed from the wide area, the Ryukyu Arc to the southeastern margin of the shallow shelf areas, to the axial part of the trough, the Yaeyama Graben area (Fig. 2).

(7) In each unit (Units A, B, and C), stratified reflectors are observed. Unit A, especially, is acoustically a highly stratified layer. Closely spaced, high-amplitude reflectors are observed within Unit B on both sides of the trough. The above reflection characters suggest that each of the units is composed of sedimentary layers. The reflectors within Units A

and B show a downward curvature toward the center of the trough. The slopes of reflectors within both the units are more gentle in the northern half of the trough area than in the southern half.

(8) Units A and B in the trough tend to become thinner toward both the sides of the trough, and to become thicker with progress of normal faulting in the axial part of the trough. Total thickness of Units A and B is more than 2.5 sec in terms of two-way acoustic travel time in the Yaeyama Graben. Unit C becomes thicker (about 1.3 sec) in the Ryukyu Arc area rather than in the shallow shelf of the East China Sea area (about 0.7 sec). According to this observation, the thickness of Unit C may be less than 1.3 sec in the whole area of the trough.

(9) Two outcrops of the acoustic basement through the sedimentaly layers (Units A, B, and C) which show topographically sea-knoll are observed within the Yaeyama Graben and in the southern margin of the trough (Figs. 3, 4 and 5). These knolls within the graben and in the southern margin of the trough are called the Yaeyama central sea-knoll (YCK) and Tarama sea-knoll (TRK) respectively (Fig. 2, KATSURA *et al.*, 1986). The relative height of these knolls above the surrounding seafloor ranges from 150 to 300 m (Figs. 4 and 5).

3-2. Seismic stratigraphy along MCS Line 2

Line 2 (Fig. 6) was planned as a line much longer than the present one across the whole area of the trough as well as Line 1 (Fig. 3), but the survey stopped at about 500 shot point due to the compressor system hung up. This profile clearly shows the structure of the southern slope of the trough. The slope is steeper than the slope along Line 1 (Figs. 3 and 5). The slopes on each profile are deformed by normal faulting. These faults can be seen to have cut the topmost sediments of Unit A, and fault blocks tilted down toward the trough axis.

3-3. Seismic straigraphy along SCS lines (Lines 3 and 4)

Figures 7 and 8 show the profiles of Lines 3 and 4 respectively across the axial part of the trough, the Yaeyama Graben (Fig. 2). These profiles and profile of Line 1 (Figs. 3 and 4) indicate that the graben is formed by normal faulting, and extended in an E-W direction with a width of about 15 km. The vertical offset along these normal faults varies from a few meters to about 35 m. The offsets are generally greater and consequently steeper on north side of the graben (Figs. 3, 4, 7, and 8).

The Irabu sea-knoll (IRK, HAMAMOTO *et al.*, 1979) on the profile of Line 4, between C and D in Figure 8, is the biggest sea-knoll within the Yaeyama Graben found in this cruise. This knoll is recognized in the eastern end area of the graben (Fig. 2). Relative height of this knoll above the surrounding sea-floor is about 300 m. On the profile of Line 4, between B and C in Figure 8, a small sea-knoll, tentatively called "DELP88 sea-knoll", is observed in the graben (D8K in Fig. 8). The above observations indicate that three sea-knolls are existence within the eastern half of the Yaeyama Graben at an interval of about 25 km.

4. Discussion

4-1. Lithology and formation age of the acoustic units

It is very difficult to estimate the lithology and age for each of the acoustic units, because of lack of drilling data in the Okinawa Trough. Several pieces of important information on the geology of the southwestern part of the trough, however, were obtained by geological studies on the Ryukyu Arc (e.g. KIZAKI, 1986; UJIIE, 1986), a petroleum exploration well drilled in the southwestern part of the Ryukyu Arc (TSUBURAYA and SATO, 1985), and a seismic profile and its interpretation just across the well (TSUBURAYA and SATO, 1985; AIBA and SEKIYA, 1979). From the results of the well, and reference to the land geology of the Ryukyu Arc, we inferred the lithology and formation age of each acoustic unit observed on the profiles of this study, as follows:

The southwestern part of the Ryukyu Arc is made up of the pre-Miocene basement complex, namely, the Paleozoic Tomuru Formation, Cretaceous Fusaki Formation, and Eocene Miyara and Nosoko Formations (e.g. KONISHI, 1965; KIZAKI, 1986; UJIIE, 1986). The pre-Miocene basement is covered with the Yaeyama, Shimajiri, and Ryukyu Groups in ascending stratigraphic order. The age of the Yaeyama Group has been assigned to the early Miocene based on paleontological data (TAKAHASHI and MATSUMOTO, 1964; NAKAGAWA *et al.*, 1982). Planktonic foraminiferal stratigraphy indicates that the formation age of the Shimajiri Group is the late Miocene to the earliest Pleistocene (e.g. UJIIE and OKI, 1974). Between both the Yaeyama and Shimajiri Groups, therefore, a great time gap is recognized. Paleontological study on nannofossils suggests that the formation age of the reefal limestone, the Ryukyu Group, is the middle to late Pleistocene (KOBA, 1980). From these studies, a hiatus of more than 0.5 m.y. is found between the Shimajiri and Ryukyu Groups (UJIIE, 1980).

The stratigraphic column at the petroleum exploration well which is called "Miyakojima-Oki", located 25 km east of Miyako-jima (Fig. 2), is made up of about 250 meters of the late Pleistocene reefal limestone and sandstone, about 2300 meters of the Pliocene mudstone, and about

900 meters of the early Miocene sandstone with limestone and coal beds; these are mainly based on paleontological studies, and the layers are correlated with the Ryukyu, Shimajiri, and Yaeyama Groups, respectively (TSUBURAYA and SATO, 1985).

The boundaries of each of the Ryukyu, Shimajiri, and Yaeyama Groups, observed in the column at the well are clearly shown on a seismic profile just across the well (TSUBURAYA and SATO, 1985). The recorded section corresponds to two-way acoustic travel time in seconds with prominent reflectors as follows; sea floor at about 0.40, first sub-bottom reflector correlated to the boundary between the Ryukyu and Shimajiri Groups at about 0.70, and second at 2.36 correlated to the boundary between the Shimajiri and Yaeyama Groups.

The acoustic units of the Ryukyu Arc area observed on the profile of Line 1 (Figs. 3 and 5) show similar acoustic characters to those on the profile just across the well. There is a similarity in thickness between Unit C of the arc area and the Shimajiri Group distributed around the well, that is, the thicknesses of Unit C and the Shimajiri Group are about 1.3 sec and 1.6 sec in two-way acoustic travel time, respectively.

Paleontological studies on molluscs (OGASAWARA and MASUDA, 1983) and on benthic foraminifera (UJIIE, 1990; personal communication) from the Shimajiri Group indicate that the paleoenvironment of the deposition was 200 to 1000 m in depth. These paleontological results suggest that the deposition of the Shimajiri Group was done in nelitic to bathyal environments like continental shelf or slope. Previous seismic reflection studies (e.g. AIBA and SEKIYA, 1979; KATSURA *et al.*, 1986) and geological studies on land (e.g. KIZAKI, 1986; UJIIE, 1986) suggest that the Shimajiri Group have a wide distribution from the Ryukyu Arc to shallow shelf of the East China Sea areas and that the thickness of the group tends to increase toward the arc area.

On the basis of the above observations, the most continuous acoustic sequence detected in this study, that is, Unit C, seems to be the layer comparable with the late Miocene to the earliest Pleistocene (mainly the Pliocene) Shimajiri Group generally composed of muddy materials. Supposing Unit C is mainly made up of the Pliocene Shimajiri Group, Units A and B can be correlated with the Quaternary layers. Also Unit D, acoustic basement of the Ryukyu Arc and Shallow shelf of the East China Sea areas, could be correlated with the pre-Miocene (mainly the Cretaceous to Paleogene) to Miocene basement rocks and sediments. Then the uppermost part of Unit D of the Ryukyu Arc area could be correlated with the early Miocene Yaeyama Group composed of alternate sand and silt layers with limestone and coal beds.

On the basis of geological and geomorphological studies, UJIIE (1980) proposed a Quaternary geological history of the southwestern part of the Ryukyu Arc mentioned below in ascending order: Firstly, folding of the Shimajiri Group produces a huge island mass comparable to the Recent island shelf in size (about 500 m water depth, Figs. 1 and 2). Secondly, the island mass composed mainly of muddy materials, the Shimajiri Group, is rapidly cut down below the sea-level. Finally, coral reef develops on the wave-cut surface.

The first stage of the above geological history suggests that the recent Ryukyu Arc area was uplifted at about the Plio-Pleistocene boundary and, at the same time, the prototype of the Okinawa Trough was originated. Also, the second stage suggests that the debris from the island mass was deposited on the Shimajiri Group of the trough area in the early Pleistocene. And the final stage indicates that simultaneously with the formation of the Ryukyu Group on the island shelf the deposition of sediments seems to have continued in the trough area during the middle Pleistocene. From these interpretations which are refered to the geological history by UJIIE (1980), Unit B2 could be mainly correlated with the debris from the arc area in the early Pleistocene, and Unit B1 could be correlated with the middle Pleistocene sediments.

The results of piston-cores taken from the trough floor by HONZA *et al.* (1976) and by HERMAN *et al.* (1978) indicated that the topmost part of Unit A is composed of the Recent intercalated turbidites and clays. Since each seismic profile of this study show that Unit A is highly stratified, it is probable that this unit is composed entirely of turbidites and clays. Unit A, therefore, could be correlated with the late Pleistocene to Recent turbidites and clays.

4-2. Faulting and tilting

Distribution of the normal faults on the profile of Line 1 (Fig. 3) indicates that there are two phases about formation and development of the southwestern part of the Okinawa Trough. One is characterized by the faulting developed within Units C and B2. Morphology of the surface of Unit C displays horst and graben structures due to this normal faulting in the whole area of the trough. The other is characterized by the faulting which can be seen to cut the topmost part of Unit A (Fig. 4). This faulting is confined to the trough axis, the Yaeyama Graben area, and is absent in the remaining part of the trough floor. Unit A appears to be deformed only by this faulting.

On the basis of the descriptions of the former section, the formation ages of the acoustic units, Units A, B, and C, could be correlated with the late Pleistocene to Recent, early to middle Pleistocene, and late Miocene to the earliest Pleistocene (mainly the Pliocene), respectively in

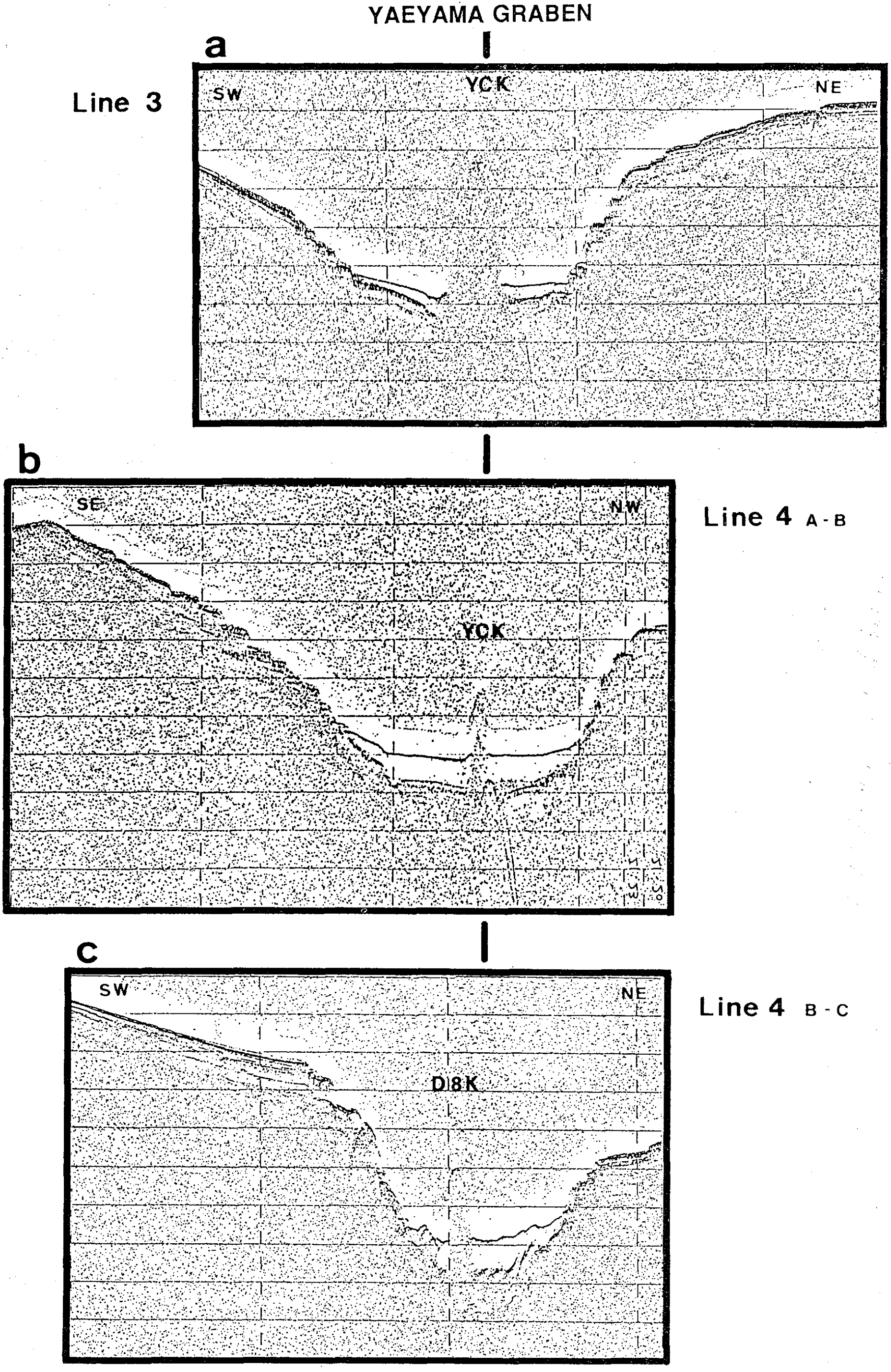

Fig. 9. Acoustic character of the central portion of the southwestern part of the Okinawa Trough, the Yaeyama Graben (Fig. 2), on 3.5 kHz records along a part of Line 3 (a) and Line 4 (b and c). YCK=Yaeyama central sea-knoll. D8K=DELP88 sea-knoll (tentative name).

descending stratigraphic order. If so, the deformation observed within Unit C originated at about the Plio-Pleistocene boundary on the whole area of the trough. Then this extensive deformation had continued to the early Pleistocene and ceased before the middle Pleistocene. On the other hand, the deformation observed in the axial part of the trough can be seen in progress along the Yaeyama Graben. This normal faulting appears to be in the central portion of the trough and is recorded prominently on the simultaneously recorded 3.5 kHz profiles (Fig. 9).

In addition to the above observations, each profile indicate that the tilting and subsidence of acoustic units toward the trough axis have occurred with progress of the faulting (Figs. 3, 7, and 8). According to the onlapping features of Units A and B, the age of the tilting is generally Pleistocene. An increase in the total thickness of Units A and B toward the trough axis is uniformly observed in the whole area of the trough on each profile, indicating that the depositional axis of the trough has been fixed during the period while the sediments, Units A and B, were deposited. Also, the thickness of Unit A increase toward the trough axis; this indicates that the tilting and subsidence with faulting in the central part of the trough, the Yaeyama Graben, are still active today.

4-3. Back-arc volcanism

Some sea-knolls, outcrops of the acoustic basement through the sedimentary units (Units A, B, and C), are observed within the Yaeyama Graben on the seismic profiles (Figs. 3, 7, and 8) and the simultaneously recorded 3.5 kHz profiles (Fig. 9). These knolls are associated with magnetic anomalies, suggesting that a volcanic intrusion occurred (FURUKAWA *et al.*, 1991; see Part 5 of this report). Various kinds of igneous rocks dredged from these knolls, the Yaeyama central and Irabu sea-knolls (Hydrographic Department of Maritime Safety Agency, 1987; OSHIMA *et al.*, 1988; ISHIKAWA *et al.*, 1991, see Part 6 of this report), indicate that the bimodal and/or island-arc type volcanisms occurred within the graben during the Quaternary.

In the Yaeyama Graben, a remarkable transparent layer is recognized around the knolls on the 3.5 kHz profiles (Fig. 9). The ristricted distribution of the acoustically transparent layer within the Yaeyama Graben suggests that the deposition of the layer has been associated with the back-arc volcanism in the graben. If the transparent layer is composed of volcanogenic materials, the age of the back-arc volcanism could be correlated with the very recent time.

5. Summary

On the basis of the description in the above sections, a tectonic evolution of the southwestern part of the Okinawa Trough may be summarized as follows:

(1) During the late Miocene to the earliest Pleistocene (mainly the Pliocene), the present trough area has formed a part of the relatively shallow continental shelf or slope, and also the present Ryukyu Arc area has been located at the southeastern margin of the shelf. In this period, Unit C (the Shimajiri Group), was deposited on the basement of the shelf.

(2) At about the Plio-Pleistocene boundary, an extensive deformation by normal faulting originated in the present trough area, and formed the prototype of the trough. At the same time, the present Ryukyu Arc area was uplifted.

(3) The extensive deformation with normal faulting and subsidence of the trough floor continued during the early Pleistocene when Unit B2 deposited, and ceased before the middle Pleistocene time.

(4) After the deposition of Unit B2, tilting of the trough floor toward the axial part of the trough had continued, and formed the approximate features of the present trough.

(5) Rifting and subsidence are in progress just along the axial part of the trough, the Yaeyama Graben, and both sides of the trough. In particular, back-arc volcanism which shows the bimodal and/or island arc type activity has occurred within the Yaeyama Graben in the Quaternary.

(6) Now the trough is still in a rifting stage. The back-arc spreading, however, might has recently initiated only in the axial part of the trough, the Yaeyama Graben.

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DELP 1988年度沖縄トラフ海域研究航海報告
2. 沖縄トラフ南西部における反射法地震探査

神戸大学理学部 古川雅英
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1988年7月，沖縄トラフ南西部を中心に DELP 研究航海が実施された．本航海では，トラフ南西部を南北に横断する4測線において反射法地震探査が行われた．その結果，トラフに分布する音響層は，正断層による変形の程度および堆積構造から，前期中新世から現在までに堆積したと考えられる3層準に区分される．広域かつ規模の大きい変形が認められるのは，トラフ底において島尻層群に相当すると考えられる音響基盤である．上位の堆積層中に発達する反射面は．トラフの中軸部に向って傾動しており，トラフ底全体が沈降を続けてきたことが推定される．トラフの中軸部には，現在も活動的であると思われる正断層によって形成された明瞭な海底地溝が認められる．この海底地溝に沿った断層に伴うトラフ底の沈降は，特に顕著なものであり，往復走時で2.5秒を越える堆積物が認められる．地震探査記録に認られたこれらの構造から，沖縄トラフ南西部の形成は大陸地殻の rifting によるものであることが示唆される．また，その形成は，おもに第四紀以降に行われたことが推定される．