## II-6. CONTINUOUS SEISMIC REFLECTION PROFILING SURVEY

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Continuous seismic reflection measurements were made along the ship's tracks shown in Fig. II-1-1. The seismic source was a BOLT PAR 1900 B air gun (120 cubic inches = 1980 $cm^3$) operated at a pressure of 1200–1500 psi (approximately 80–100 $kg/cm^3$) and a firing interval of every 10 seconds. Seismic signals were detected by a Teledyne

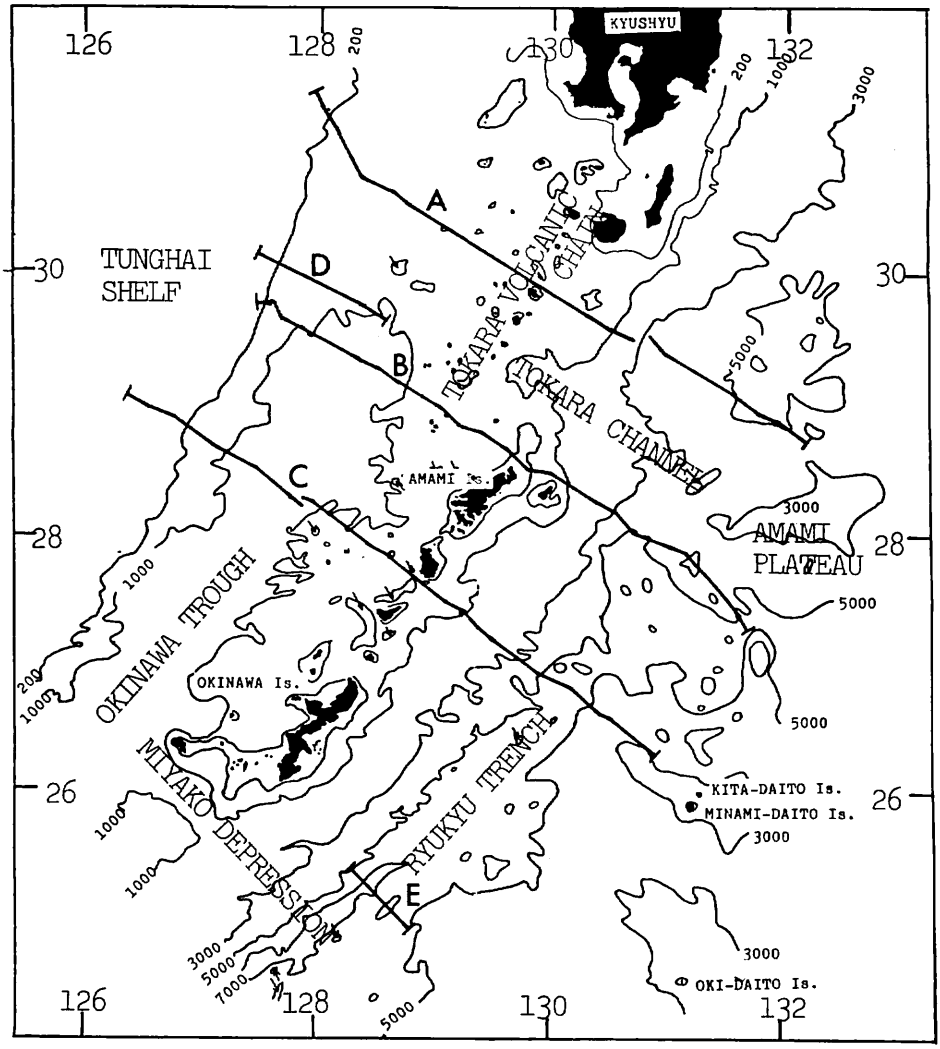

Fig. II-6-1 Location map of profiles, A, B, C, D, E. Bathymetry in meters from Japanese bathymetric chart 6302.

Hydrostreamer with 50 crystal hydrophones towed 150 m behind the ship. These signals were processed through Geo-Space seismic amplifiers with filters passing 25–125 Hz (at the area of deeper than 200 m) or 40–160 Hz (at the area of shallower than 200 m), and displayed by a Reytheon Universal Graphic Recorder Operated at a 4-sec sweep. Ship speed was maintained at 11–12 knots during the survey.

## Results and Preliminary Interpritations

### (1) Tunghai Shelf

The surveyed tracks are only on the marginal area of the Tunghai Shelf. An acoustic basement high is observed on the profile illustrated in Fig. II–6–2a, and c. This basement high may correspond to the Taiwan-Sinzi folded zone which is considered to be composed of consolidated sedimentary and igneous rocks of Tertiary age (WAGEMAN *et al.*, 1970). The sediments around the basement high are remarkably deformed as shown on the profile in Fig. II–6–2a.

Many normal faults are detected on the slope of the Okinawa Trough as shown in Fig. II–6–2a, b, c, but an uplifted block is observed on some of the profiles (Fig. II–6–3). This uplifted block has a ENE trend, oblique to the slope. Thus, the slope, the junction of the Tunghai Shelf and Okinawa Trough, is tectonicaly complex, which makes it difficult to detect the continuation of the trough sediments and the shelf sediments. Probably, the tectonics are closely associated with the formation of the Okinawa Trough.

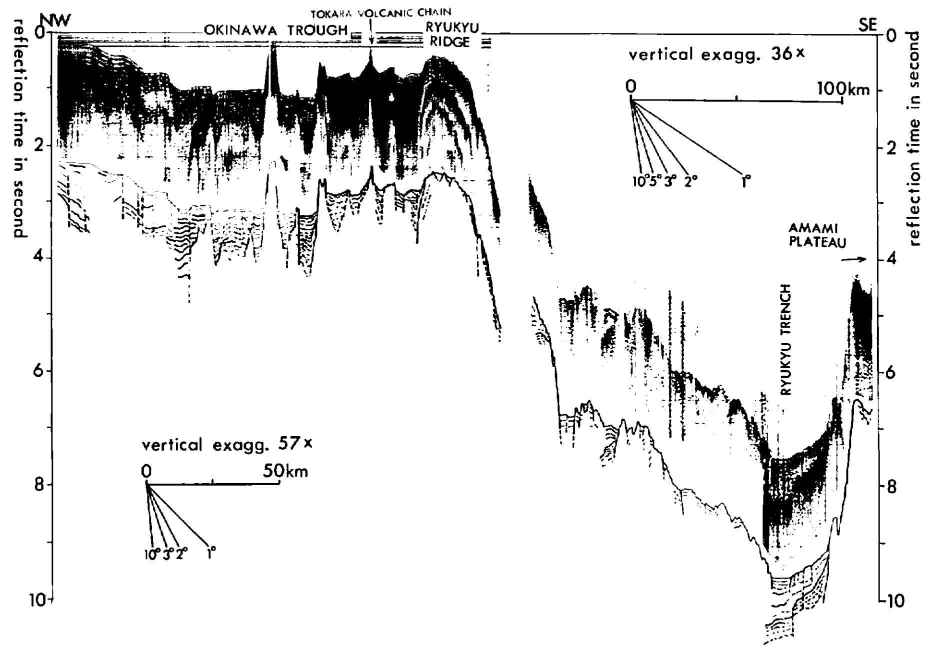

Fig. II–6–2a Continuous seismic profiling records with line drawings of profiles along ship's tracks shown in Figure II–6–1, A.

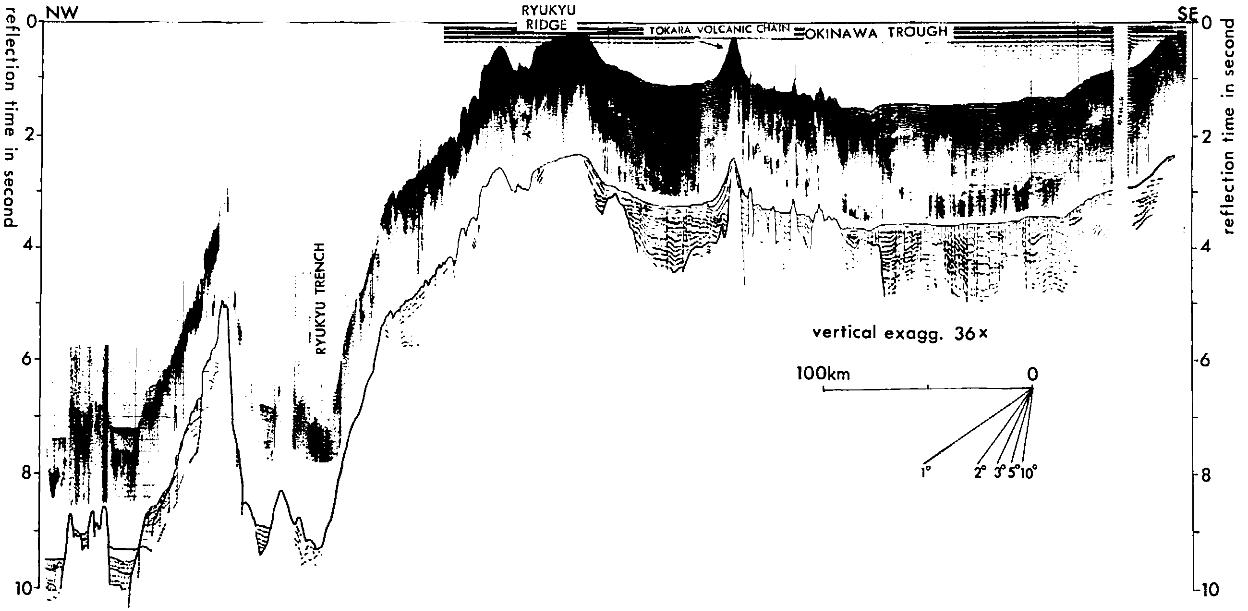

Fig. II–6–2b Continuous seismic profiling records with line drawings of profiles along ship's tracks shown in Figure II–6–1, B.

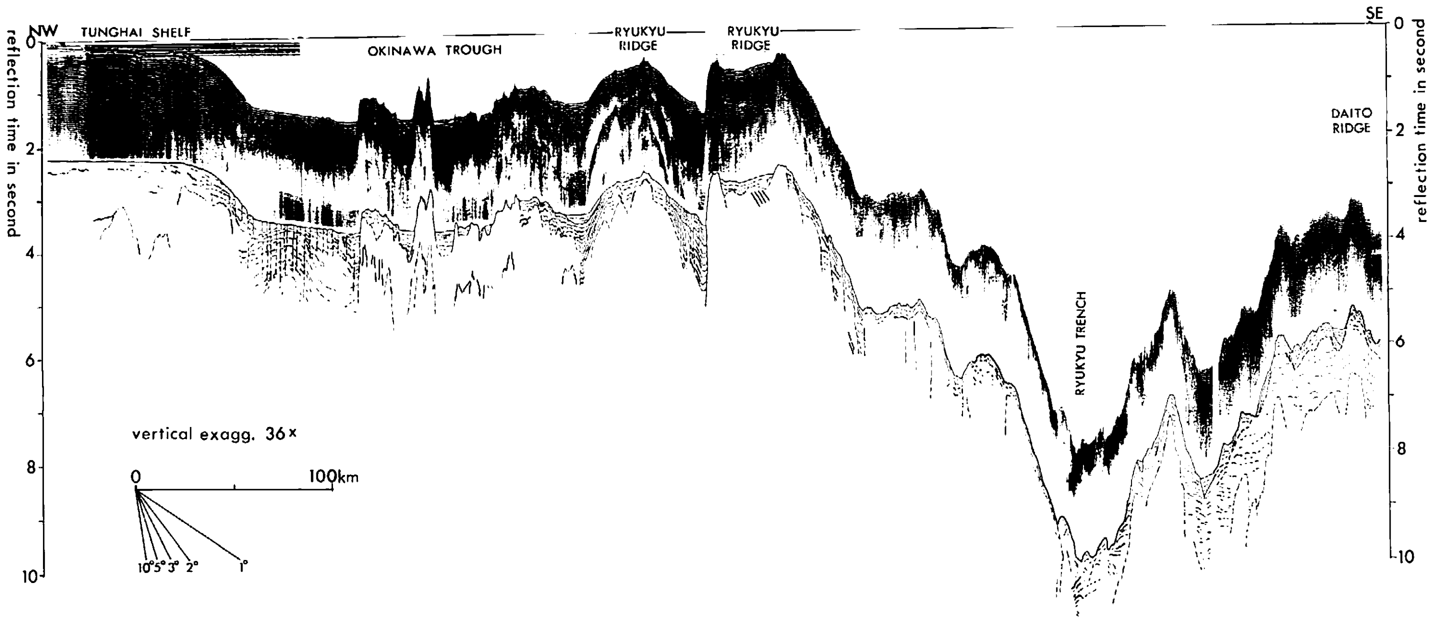

Fig. II–6–2c Continuous seismic profiling records with line drawings of profiles along ship's tracks shown in Figure II–6–1, C.

### (2) Okinawa Trough

The western half of the Okinawa Trough consists of a very thick sedimentary basin with a flat floor where acoustic basement could not be detected, and the sediment fill exceeds 1.5 sec of reflection time (Fig. II–6–2). The sediments in the trough have many subbottom relectors and are highly deformed with numerous vertical reverse faults which probably have a NE to ENE trend, slightly oblique to the trough axis. These faults are clearly detected by the profile of the 3.5 kHz echo sounder as shown in Fig. II–3–2, and indicate structural evidence of very recent activity. Such recent tectonic activity corresponds with the distribution of shallow earthquake epicenters over the period 1963–1972 in the Okinawa Trough (TARR, 1974).

According to the results of sea bottom sampling by piston corer during this cruise (ST 384, 390, 392, 394) and of the GH 75–1 cruise in the southern Ryukyu area (ST 191, 196, 198), these subbottom reflectors may correspond to pumice layers, volcanic sand layers or turbidite sand layers.

There is the rough topographic zone in the eastern area of the trough. There are many small peaks and seamounts composed of acoustic basement present and many small basins with one second thickness among these topographic highs (Fig. II–6–2). The sediments in lower part of these basins are folded while the sedimentary layers are not deformed.

This area is a volcanic zone of Neogene to Quaternary age (KONISHI, 1965), and a line of Quaternary volcanos including some active ones occur in the eastern most part of this province. This volcanic line is called the Tokara Volcanic Chain.

The third feature of the Okinawa Trough is a narrow basin occuring between the Ryukyu Ridge and the Tokara Volcanic Chain, typically shown in the profile of Fig. II–6–2b. In this basin, sediments of 1.5 sec in thickness, are observed. The lower layers of the sediments in this basin are more weakly folded and faulted, in comparison with the deformation in the western half of the Okinawa Trough, and the upper layers are less deformed than the lower areas. The sediments abut against the basement of the Ryukyu Ridge. The boundary with the Tokara Volcanic Ridge is not clear.

### (3) Ryukyu Ridge

This province is called the Ryukyu Geanticline by KONISHI (1965), and consists of a folded sedimentary sequence of Lower Neogene, Paleogene to Paleozoic sediments including igneous and metamorphic rocks of unknown age overlain unconformably by relatively undeformed sediments of Upper Neogene and coral reefs of Pleistocene age. The Ryukyu Ridge is mostly composed of acoustic basement, and the structure can only be weakly detected by reflection seismic profiling (Fig. II–6–2).

In the vicinity of Okinawa Island, the Ryukyu Ridge is composed of two ridges and an active trough is observed between these two ridges (Fig. II–6–2c).

### (4) Continental Slope and Trench Slope

The boundary between the continental slope and the trench slope is termed the trench slope break as shown typically in Fig. II–6–2b. The trench slope break is well developed at a depth of 2300–3000 m (Fig. II–6–2a, b, c). A typical deep-sea terrace, which is well developed off SW Japan, is not observed in the surveyed area, however two terraces with rough surfaces are present in some profiles (e.g. Fig. II–6–2c). Faulted and folded sediments are present on these terraces and on the continental slope.

According to the results of the gravity measurements of this cruise, there is predominant gravity minimum of the free air anomaly over the continental slope where the refraction data (LUDWIG *et al.*, 1973) suggests the presence of a thick 3.3 km/sec layer. However, the feature which corresponds to these geophysical results is difficult to detect by seismic reflection profiling on account of the lack of acoustic penetration. This lack of penetration suggests the presense of highly deformed sediments.

The trench slope is steeper than 10° and acoustic penetration is weak which may indicate exposure of basement rock. However, according to the results of dredge haul by the GH 74–7 cruise from the trench slope at a depth of 4300 m, there is a thin cover of sediments (MIZUNO, ed., in prep.).

On the lower part of the northern area of the Tokara Channel, a very gentle slope (1–2 degrees) with a rough surface is present as illustrated in Fig. II–6–2a. This slope is composed of many small hills and sediment filled basins which resemble the features of the trench slope off SW Japan (INOUE ed., in prep.). Probably, these small hills are composed of highly deformed sediments and the sediment filled basins consist of post-deformation sediments. These post-deformation sediment fills are not seen in the vicinity of the trench. This fact may suggest evidence of Recent activity in the vicinity of the lower most part of the trench slope. The highly deformed trench slope is closely associated with the occurrence of terrigenous or semi-pelagic sediments in the area beyond the trench, which are known to be present in the northern area of the Tokara Channel. From this, the highly deformed sedimentary wedge is inferred to be the accretionary prism of subduction activity (KARIG and SHARMAN III, 1975).

### (5) Ryukyu Trench

The floor of the Ryukyu Trench deepens southwards from 5600 to 7200 m off the Miyako Deppression, but there is a topographic high in the trench off the Tokara Channel.

In the southern part of the trench (Fig. II–6–4) and the northern part (Fig. II–6–2a), the trench has a sedimentary filling of 5–10 km in width and 0.2–0.4 sec in thickness.

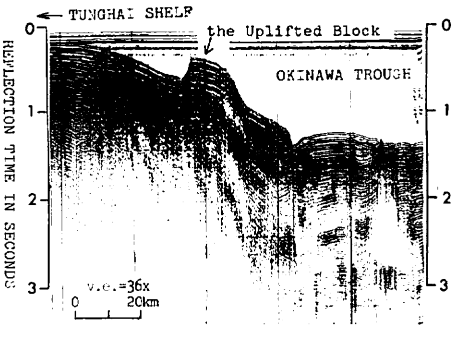

Fig. II–6–3 A continuous seismic profiler record ship's track shown in Figure II–6–1, D.

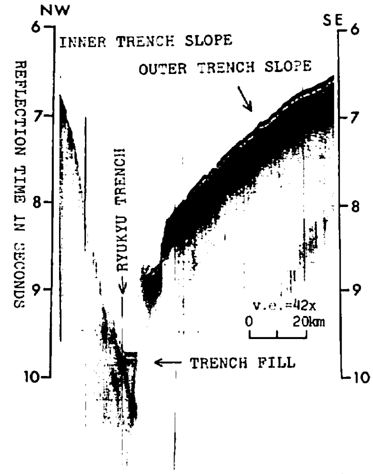

Fig. II–6–4 A continuous seismic profiler record ship's track shown in Figure II–6–1, E.

The sediments have coherent subbottom reflectors, which are characteristic of turbidite layers, and have no detectable deformation. However, the lower sediments beneath are certainly deformed.

There is no trench fill sediments in the central part of the trench, although, highly deformed sediments are present. These deformed sediments are correlated to the above-stated lower deformed sediments.

The formation of the trench sediment fill may be correlated with the depth of the trench and the supply of terrigenous sediments. The presence of such undeformed sediments on the trench floor has been given as counter-evidence of subduction (HELWIG and HALL, 1975).

### (6) The Outer Region beyond the Trench

The Outer Region is divided into three areas on the basis of characteristics of topography and sediments.

In the northern part, thick sediments are present. The upper layers belong to the transparent layer of 0.3–0.5 second thickness and the lower layers are stratified layers of 0.4–0.6 second thickness (Fig. II–6–2a).

In the southern part, the veneer of the transparent layer sediments is present on the acoustic basement which declines into the trench (Fig. II–6–4). There is some difficulty in identifying the constituents of this acoustic basement as the reflectors suggest a sedimentary origin rather than oceanic basalt.

The central part of the region is characterised by complex topography composed of many deep sea mountains, ridges and basins (Fig. II–6–2b, c). These basins contain no disturbed sediments of 0.4–0.6 second in thickness.

All profiles of the outer region show the presence of highly deformed sediments in the vicinity of the trench with pronounced differences in the structure of both sides of the trench. These features lend confidence to the fact that the Ryukyu Trench is an active tectonic structure.

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