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XII. CONTINUOUS SEISMIC PROFILING SURVEY IN KASHIMA-NADA, GH80–3 CRUISE

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Introduction

Continuous seismic reflection profiling survey was carried out along the survey tracks shown in Fig. I–2. Survey equipment and operating conditions are described on Table XII–1. Five profiles of E-W tracks (L2, L8, L12, L24, and L32) and two of N-S tracks (LC and LG) are shown in Fig. XII–1a to 1g with interpretative line drawings. We use two way travel time in order to describe the thickness of formations and the depth of reflectors.

Results

The distribution of the continental shelf and the folding axes are shown in Figure XII–2. The shelf shows a big concave shape morphology open to the east. The northern part continues to the wide shelf off Shioyazaki.

Basement High off Choshi The southern continental shelf is made of the basement high which continues from the Choshi Peninsula. The basement high is probably composed of Permian-Cretaceous and Miocene strata, judging from land geology around the Choshi Peninsula. These formations show highly opaque character on the profiles and severe faultings and foldings. The folding axes show E-W trend in the north, NW-SE in the middle, N-S in the south, NE-SW in the southwest of the basement high. The exposure of the basement is shown by the dotted area 1 in Fig. XII–2.

Table XII–1. Survey equipment and operating conditions

1) Equipment	
Air Gun	Bolt PAR Air Gun 1900C (with wave shape kit) × 1
Compressor	Norwalk APS-120
Receiver	Hydrostreamer with 98 elements of Teledyne T-1
Amplifier	Ithaco 3171 and 451
Recorder	Raytheon LSR 1811
e) Operating conditions	
Total volume of Air Guns	120 in^3 (1967 cm^3)
Pressure	1500 psi (105 kg/cm^2)
Shot interval	8 sec
Filter range	50 to 160 Hz band pass
Record range	4 sec
Ship speed	10 knots
Hydrostreamer	towed 150 m behind the ship

In the western side of the basement high, there is a northeastern margin of the Pliocene-Pleistocene sedimentary basin of the Kazusa Group which is widely distributed in the Kanto Basin. The formations deposited in the basin of this area show a WSW dip and an NWN strike. They show few tectonic disturbances. The acoustic character is semi-opaque and fine stratification in the upper part, and transparent and broad banded stratification in the lower part. The total thickness amounts to over 1,000 m at the southwestern corner of the area. The boundary between the formations and the older formations which continue from the basement high is clear clino-unconformity (Fig. XII-1a).

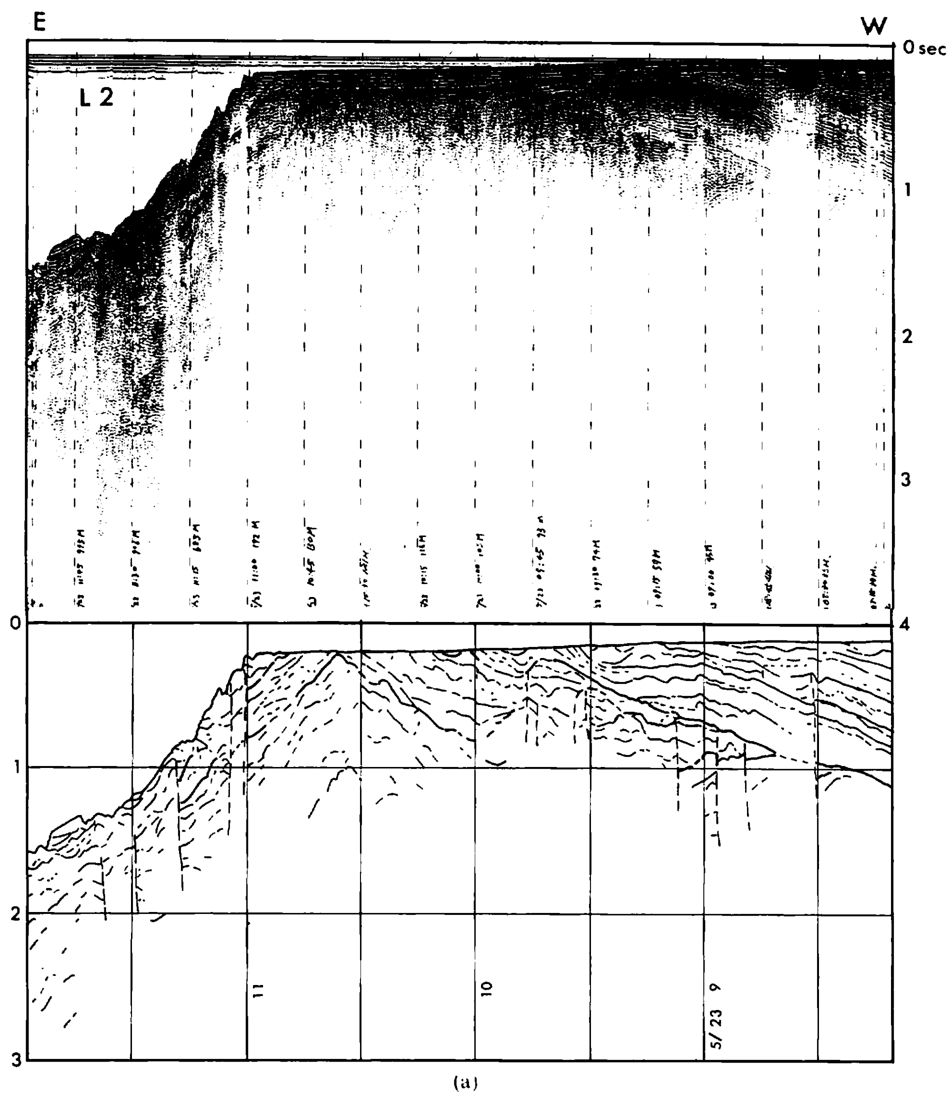
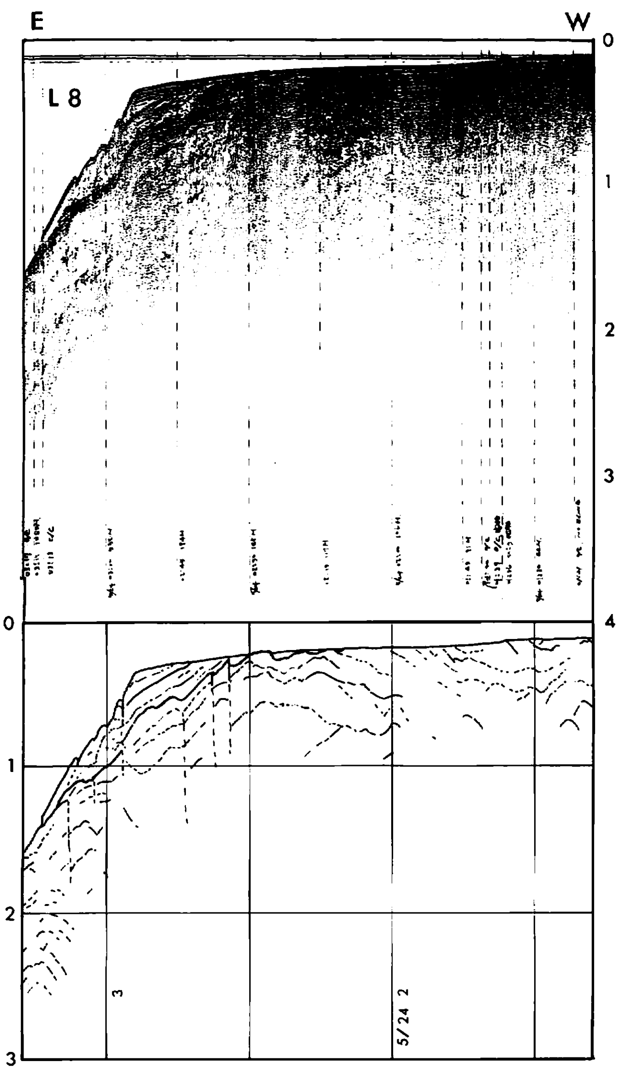
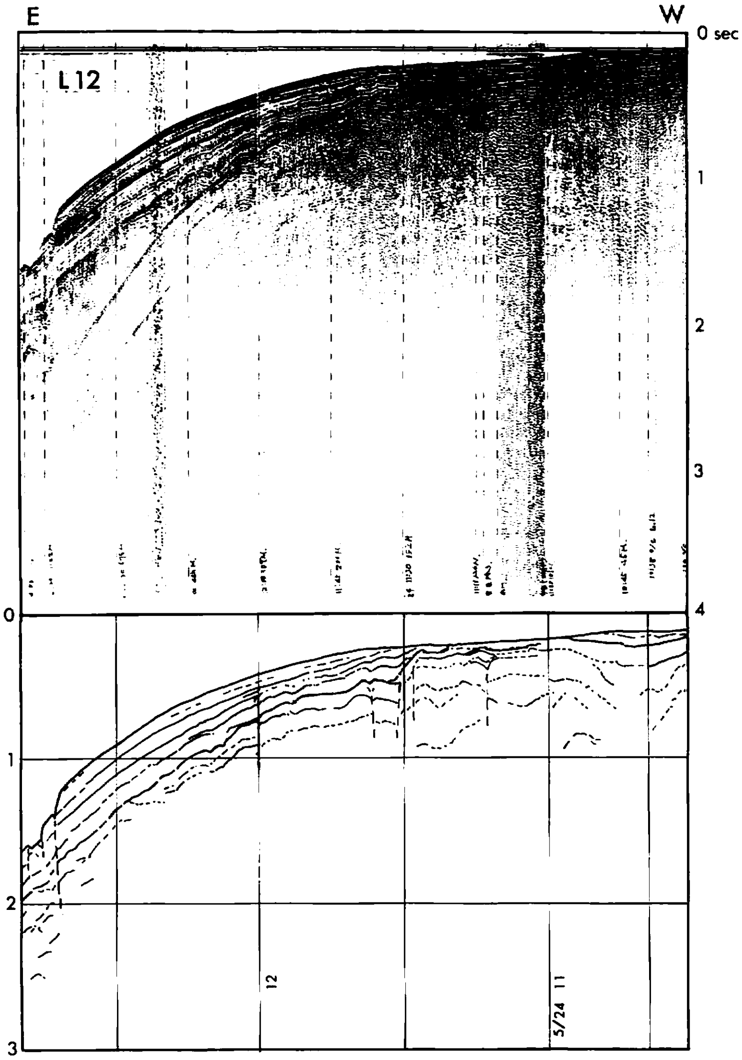


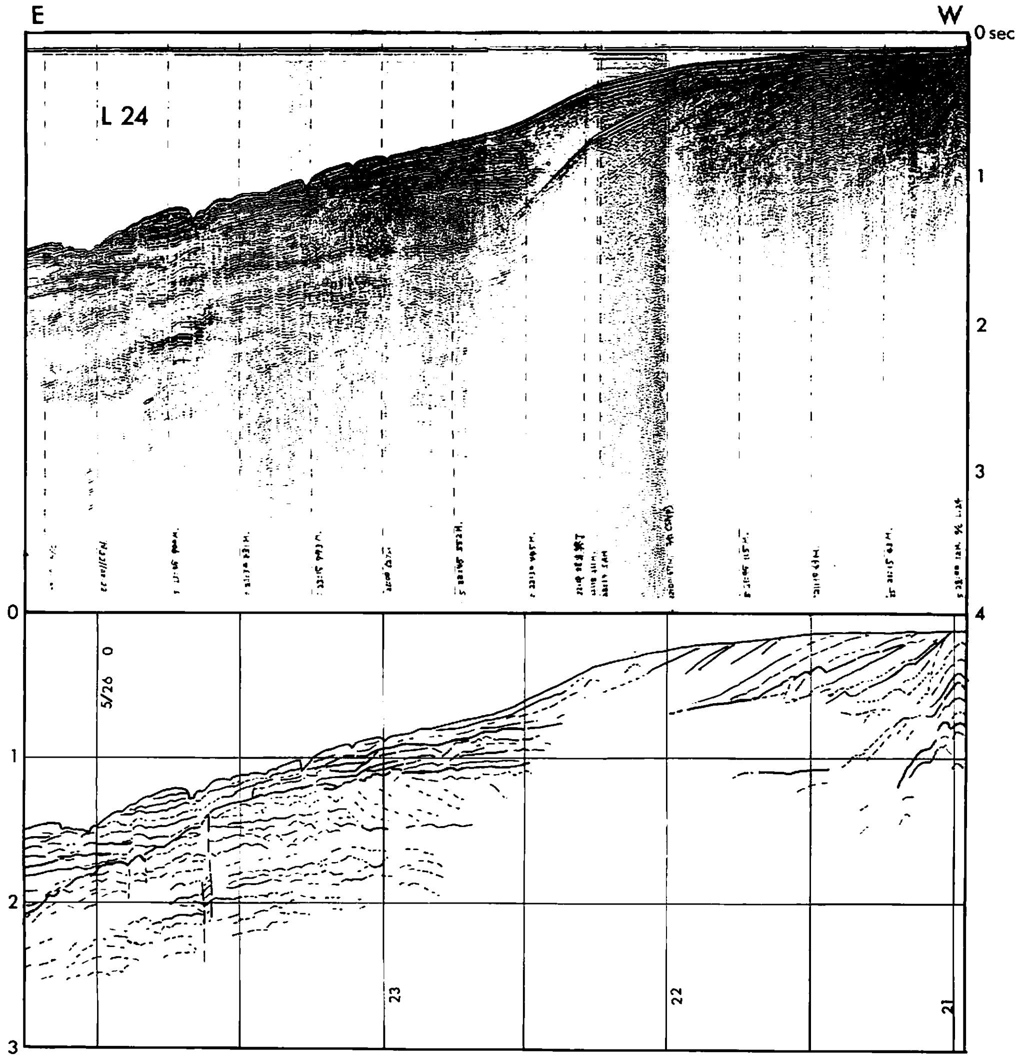
Fig. XII-1a to 1g Some examples of continuous seismic profiles with interpretative line drawings.



(b)



(c)



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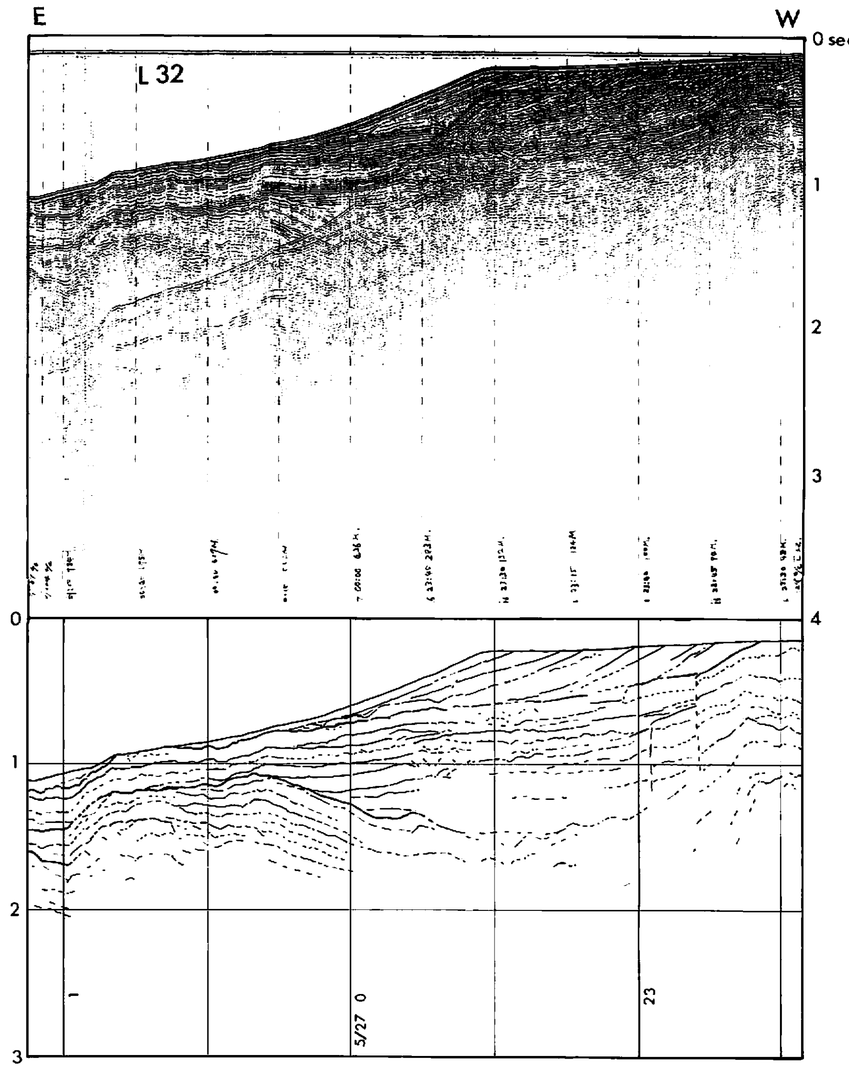

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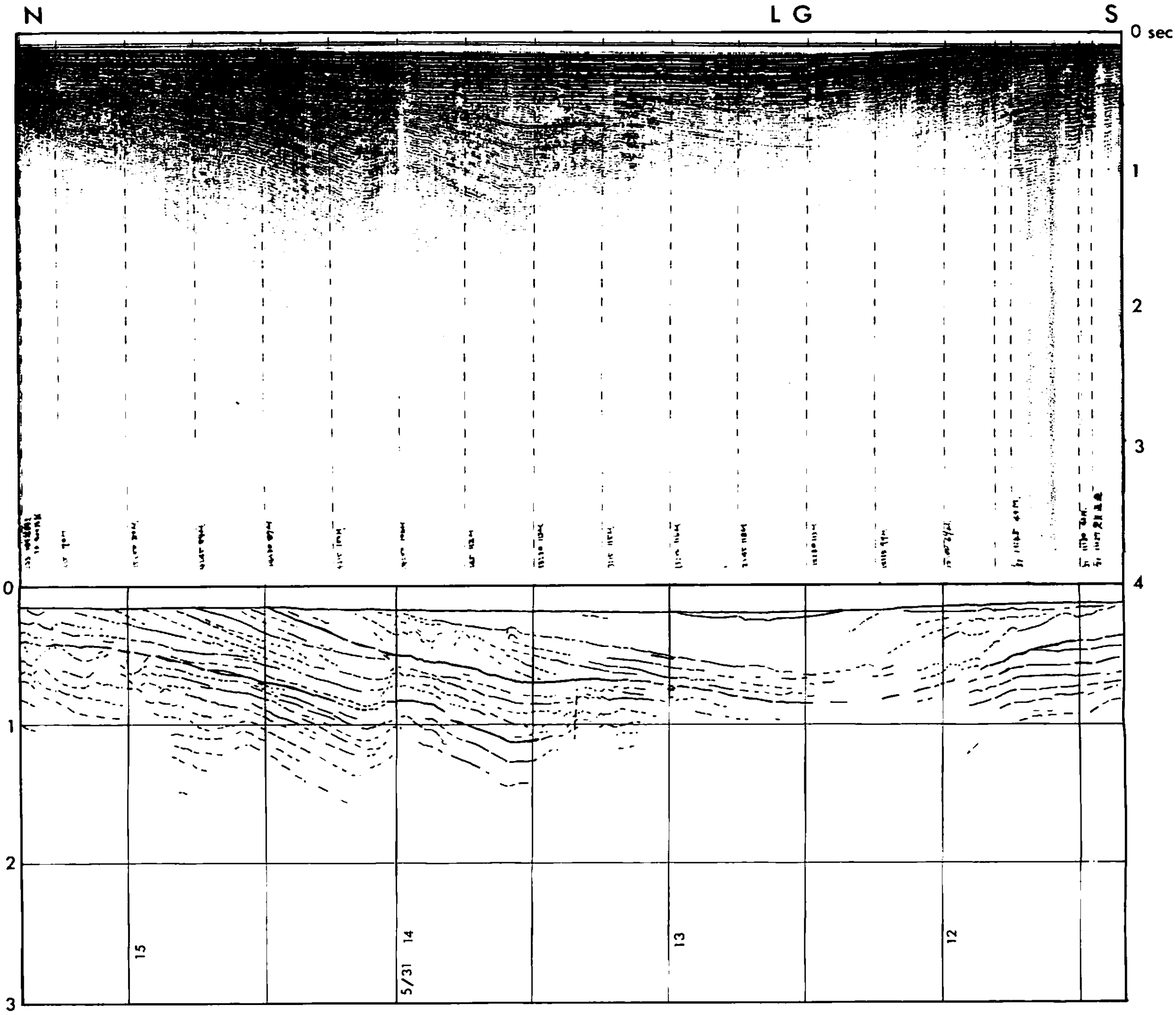

(f)

In the eastern side of the basement high, there are thin acoustically transparent formations which are comparable with those in the western basin (Fig. XII–1a and 1b). They are eroded by many submarine channels in places (Fig. XII–4). There are thick acoustic alternations of transparent and semiopaque patterns without clear unconformity. They may be compared with the middle Miocene to early Pliocene Awa Group in the middle of the Boso Peninsula.

Basin In the northern side of the basement high, there are several formations with unique acoustic character and configuration as sedimentary body. The boundary between them and the older formations which form the basement high is not clearly observed on the profiles, but upper formations dip steeply and thicken to the north, and the boundary area shows a fold belt with an E-W trend (Fig. XII–1g). Then there is probably an important tectonic boundary between the southern basement high and the northern depositional basin. It may be compared with the eastern elongation of the Median

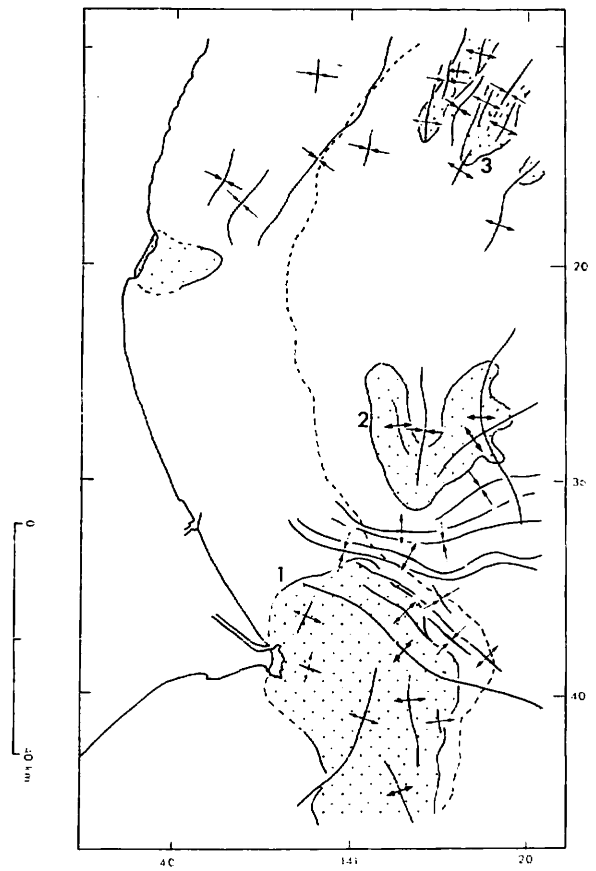

Fig. XII–2 Structural map of Kashima-Nada area. Shelf edge is shown by dot line. 1) Older basement high off Choshi. 2) Exposure of Unit B. 3) Exposure of Unit D and/or Unit E at the offshore basement high.

Tectonic Line which divides Southwest Japan into the inner and outer belts and is estimated under the Kanto Basin based on well surveys.

The formations in the basin show a gentle dip generally to the east. They can be divided into five or more formations. We divide them into five on the typical profile L16 and call them from upper to lower, as Unit A, Unit B, and so on (Fig. XII–3).

Unit A which shows semi-transparent character on seismic profiles is widely observed on the continental shelf. It has inner structure like a foreset body, that is, the inner layers show steeper dip than those of upper and lower boundaries of the unit, and make cross bedded structure. The shoulder of the outermost layer which is the frontal wall of the unit makes the shelf edge. Unit A also covers the upper continental slope. In the continental slope area, its configuration changes to thin drape concordant with the configuration of the formation, and the acoustic character changes to fine alternation of transparent and opaque ones. The thickness is about 0.3 sec in the shelf area, and up to 0.2 sec in the slope area. In the southern part of the deep sea terrace, one isolated distribution of Unit A is observed (Fig. XII–3).

Unit B is characterized by highly transparent pattern. It has generally smooth upper and lower boundaries, and parallel stratification concordant with the boundaries. It can be divided from Units A and C in the southern part of the basin, but cannot so easily in the northern part and under the continental shelf area (Fig. XII–1f). The unit is widely distributed with constant thickness about 0.1 to 0.2 sec, and exposed to the sea floor at the dome-like structure in the southern part of the deep sea terrace as the dotted area 2 in Fig. XII–2. The upper boundary of the unit shows slightly rugged character there (Fig. XII–3). The inner stratification becomes very clear and the acoustic character is very resemblant to Unit A at the north of the dome-like structure.

Unit C is recognized only around the dome-like structure (Fig. XII–3). It is a thin opaque stratified formation. The upper boundary with Unit B is concordant, and lower

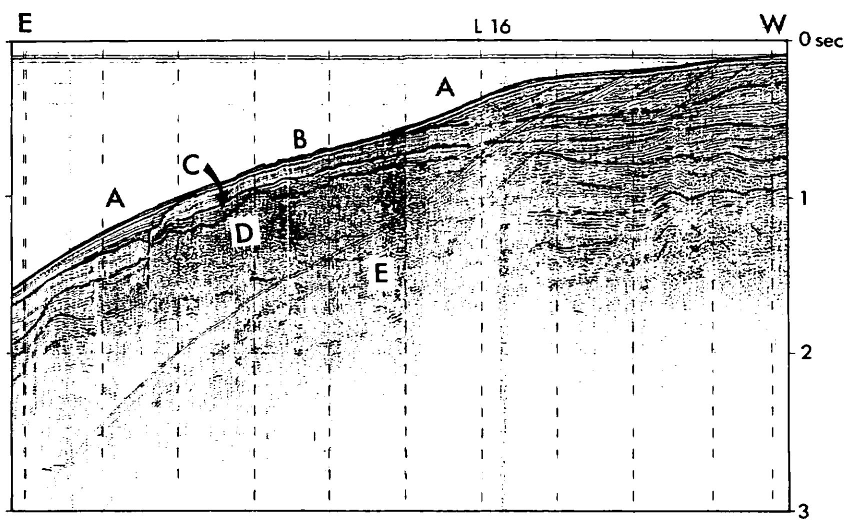

Fig. XII–3 Continuous seismic profile on Line 16 with the separative drawings of seismic stratigraphic units.

boundary with Unit D is discordant. The lower part of Unit C fills the rugged surface of Unit D (Fig. XII–4). The thickness is 0.1 sec around the dome like structure, and the probable continuation under the shelf has 0.15 sec or more thickness. In the northern part of the basin, it cannot be divided from Unit B.

Unit D is the most distinguishable formation in the basin. It shows highly dispersed pattern in the main part (Fig. XII–1f, 3, and 4). The thickness of the formation amounts to about 600 m or more. The dispersed pattern changes to an alternation of a stratified layer and a thin dispersed layer to the north (Fig. XII–3). The dispersed pattern on the seismic profiles is usually interpreted as the existence of dispersion materials with less stratification, for example, lava flows, slumped sediments, olistostromes, conglomeratic or fanglomeratic sediments, and so on. There are no large eruptive volcanoes and lava flow activities near the area, and probably less energy available to cause the olistostrome and severe slumping. The upper and lower boundaries of the probable continuation of Unit D do not show severe discontinuity. It is observed mainly at the center of the basin, and thins in the shelf area. Upper and lower surfaces of the dispersed body are observed at about 0.7 to 1.6 sec and 1.4 to 2.0 sec, respectively, and the thickness amounts to 0.6 sec. Those facts show Unit B to be deep sea fanglomeratic sediments. The deep sea fanglomerate may reflect the very high rate of sediment supply to the basin. The change of the character of the formation from the thick dispersed layer in the basin to the alternation in the north may show the transition between the main fanglomerate body and the surrounding natural levee and overflowed sediments. In the outer part of Unit D, the dispersed layer changes to the alternation of the transparent layer and the stratified layer (Fig. XII–3). The internal structure of the unit shows highly irregular shape probably caused by migration of many streams which made deep sea channels.

Unit E is one of the deepest layers in the basin. It consists of a fine stratified part and a transparent part. The lower boundary cannot be observed at the center of the basin. The

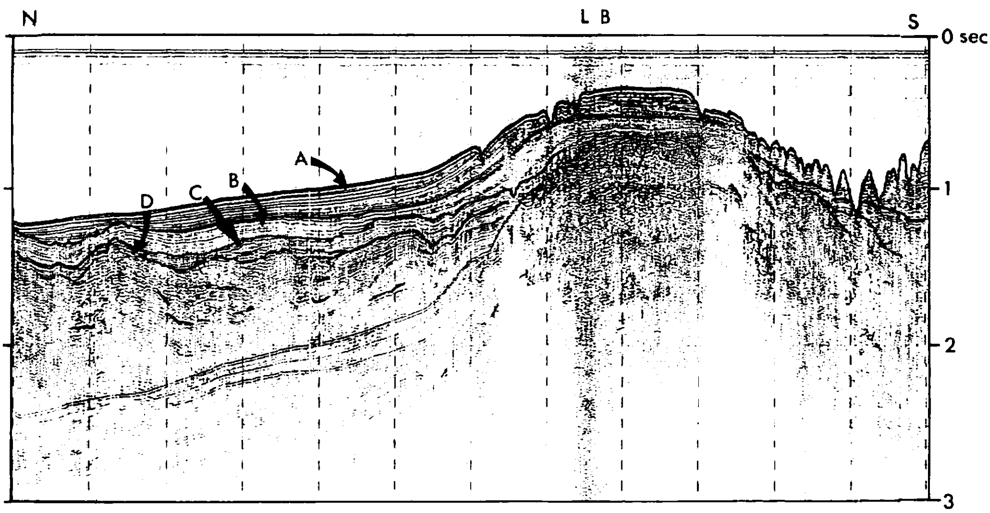

Fig. XII–4 Southern half of the continuous seismic profile on Line B.

thickness probably amounts to 1.0 sec (Fig. XII−1f).

Offshore Basement High In the northern part, there is a structural high composed of some anticlinal folds on the upper continental slope (Fig. XII−1e). Thin sedimentary drape, which is probably correlated with Unit A in the middle part of the basin, is lacked on this high. The high is typically developed off Shioyazaki north of the GH80−3 area, and it becomes deep and week in the middle part of the survey area (Fig. XII−1d). We can observe the clear unconformity overlain by on-lap formations. It shows the fact that rapid deposition in the basin between the offshore high and the coast, or a rapid sea-level fall followed by a slow rise occurred. Upper part of the on-lap formations also show the folded deformation on the high. The foreset formation develops on the continental shelf, and makes thin drape on the deep sea terrace. By the tracing of the inclined internal layers of the cross-bedded unit between some profiles, the layers show an ENE strike. The thickness of the layers above Unit D is shown in Fig. XII−5. Units B and C, which show

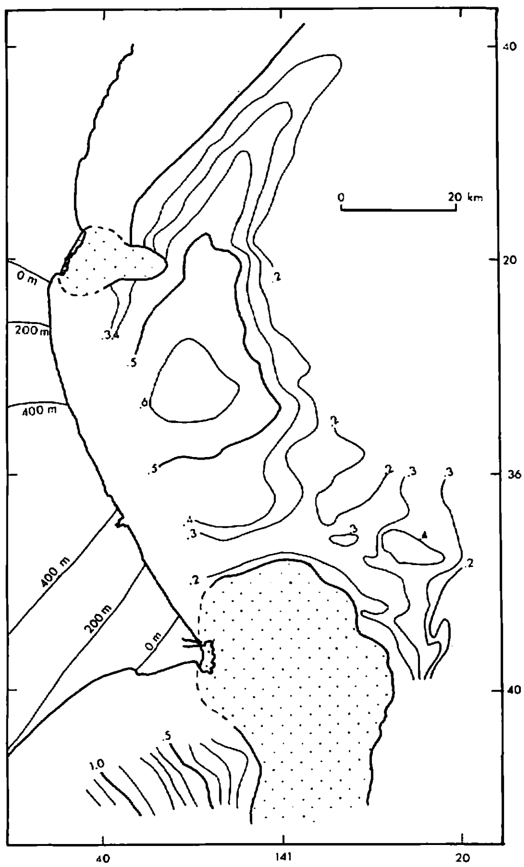

Fig. XII−5 Thickness distribution of Units A, B, and C. Unit in sec. The northwestern margin of the distribution shows the example of the strike of the internal layer composed of the cross-bedded foreset. The isodepth contours of the Quaternary basement on land are shown based on KAKIMI *et al.* (1973).

widely spreaded configuration on the shelf in the central area, change to inclined layers, and make foreset like shape in the north. The on-lap formations above the unconformity on Line 32 may be correlated with Units D and E. The unit under the unconformity (Unit F) can only be observed in the offshore anticlinal high area. It shows off-lapping character to the south in Fig. XII-1f. The thickness of Unit F amounts to 1.0 sec or more.

There is less available clonological data of the formations in the survey area. We will try the rough estimation by the comparison of sedimentary body shape character with that in the land area. Sediments with 570 m thickness of the Kazusa Group (late Pliocene to early Pleistocene) are underlain clinounconformably by 317 m thick marine Miocene sandstone and mudstone (FUKUDA *et al.*, 1974). The Kazusa group is nearly flat and Miocene sediments show about 20° dip (ISHII, 1962). Basement morphology of the major part of the Kazusa Group and that of the Miocene formations in the Kanto Plain are given by KAKIMI *et al.* (1973). Isodepth contours of both basements based on their results are illustrated in Fig. XII-5 and 6.

Units B and C show flat shape and the unconformity can be observed under them in the central part of the survey area (Fig. XII-3). The thickness distribution of them and Unit A is considerably concordant with the basement morphology of the main part of the Kazusa Group as shown in Fig. XII-5. Units A, B and C may be correlated with the Kazusa Group. The change of the layer configuration to cross-bedded form in the northern area may reflect the basemental highs in Nakaminato and in the Abukuma mountains north of Nakaminato.

The deeper unconformity is observed under the continental shelf on Line 16, which may correspond to lower boundary of Unit D or E, is traced over the shelf area between Choshi and Nakaminato where Pre-Tertiary formations crop out. The depth of the unconformity is shown in Fig. XII-6. It is fairly concordant with the Miocene basement on land area. This indicates that the unconformity may be correlated with that between Miocene and Cretaceous or older basement on land.

In the south of the Choshi Peninsula there is a remarkable clino-unconformity between upper Pliocene and Cretaceous or Permian basemental formations. The upper Pliocene formation shows coastal facies (Naarai Formation) under the Kazusa Group. Fig. XII-6 shows good concordance between Miocene basement on land and the thickness of the formation with a WSW dip which is developed west of the basement high in the southern area as shown on Line 2. This implies that the formation is correlated with the Kazusa Group and the Naarai Formation.

Unit D, highly dispersed formations in central area, may be formed at the time when severe erosions might occur at the late Miocene and early Pliocene age.

The unconformity between Miocene and older formations cannot be observed north of Nakaminato. Units E and F may be correlated with early to middle Miocene formations. The middle Miocene formation off Joban area north of the present survey area pinches out from north to south with little discordance between lower and upper Miocene formations (AIBA and TSUBURAYA, 1981). The clino-unconformity, which is observed on Line 32, may be correlated with the unconformity between early and late Miocene time. It shows less discordance at the offshore basement high area. The on-lapping lower formation over the unconformity may be correlated with middle to upper Miocene formations.

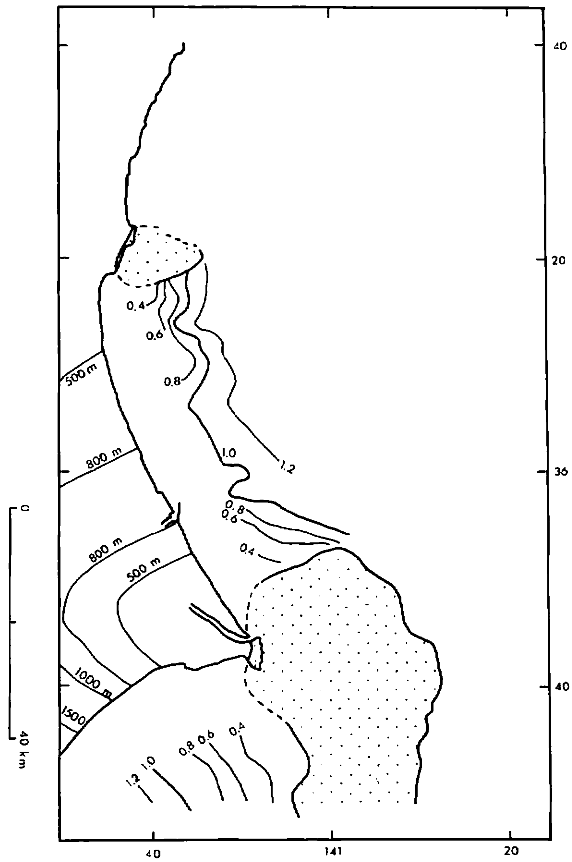

Fig. XII-6 Depth of lower unconformity between Nakaminato and Choshi, and of the upper formation WSW dip developed west of southern basement high. Unit in sec. The Miocene Basement contours on land area are shown based on KAKIMI *et al.* (1973).

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