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II. TOPOGRAPHY AND SUBSURFACE GEOLOGICAL STRUCTURE OF THE PENRHYN BASIN, SOUTH PACIFIC (GH83-3 AREA)

Yoshihisa Okuda and Jun-ichi Miyazaki

Introduction

Bathymetric and seismic reflection surveys were carried out during the Cruise GH 83- 3 around the Penrhyn Basin. The regional survey area is enclosed approximately by 12°S-14°S and 158°W-160°W and the detailed survey area by 12°50′-13°10′S and 159°05′W-159°20′W. The bathymetric survey was carried out along all the tracks in the area, using a 12 kHz precision depth recorder (PDR) of a model NS16 manufactured by the Nippon Electric Co. LTD. (NEC) with 4 kW signal output. The seismic and major bathymetric track lines are shown in Figures II-1 and II-2. The total length of the seismic lines is approximately 2,000 nautical miles.

The seismic reflection survey was carried out in the regional and detailed survey areas. During the seismic survey, two arrayed Bolt-type air guns with 150-cubic inch chamber were operated at a pressure of 1,900 p.s.i. with firing interval of 12 seconds. A streamer with 50 Geospace MP18-200 hydrophones manufactured by the Geological Survey of Japan were towed at a ship speed of 10 knots. The received seismic signals by the streamer were adequately amplified and filtered on board, and then recorded on two graphic recorders in 4 and 8 second ranges.

Bathymetry

The water depth of the ocean floor of the surveyed area ranges from 5,100 to 5,350 meters. A major depression, which forms an elongated trough, runs in the direction of N-S to N30°W-S30°E in the eastern-central part of the survey area. The maximum water depth of the bottom of the depression reaches more than 6,000 meters.

Several isolated knolls, seamounts and small ridges elevating more than 500 meters from the floor are scattered to the east of the trough. Elongated ridges run parallel to the trough axis just to the west of the trough. In contrast, the western part of the trough is characterized by flat basin floors, and no prominent topographic highs except for a few scattered small knolls are scattered.

General acoustic stratigraphy

General acoustic features in the Penrhyn Basin are similar to those in the southern Central Pacific Basin (Mizuno and Okuda, 1982). According to the previous detailed

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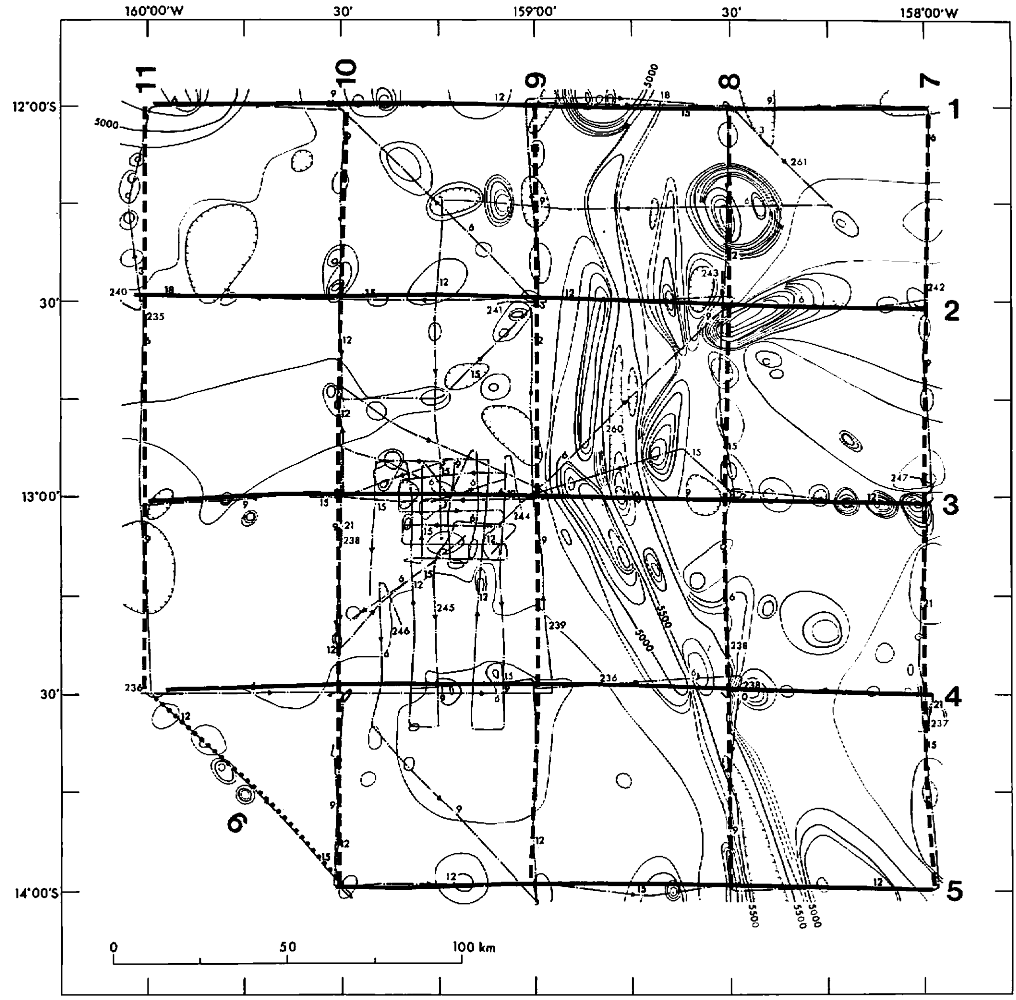


Fig. II-1 Track lines of air gun seismic survey of Cruise GH83-3 (regional survey). Bold figures denote numbers of survey lines. Lines 1 to 5 (E-W) and Lines from 7 to 11 (N-S).

acoustic stratigraphic studies in the Central Pacific Basin area (Tamaki, 1977; Murakami and Moritani, 1977; Tamaki and Tanahashi, 1981; Tanahashi, 1986, 1992), the acoustic sequences in the area consist of Unit I characterized by transparent to opaque layer, Unit II characterized generally by opaque to semi-opaque acoustic patterns, and acoustic basements. Referring to the lithostratigraphic study of DSDP Legs 17 and 33 (Winterer, E. L.; Ewing, J. I. *et al.*, 1973), the boundary between the Unit I and Unit II seems to be correlated to the early Oligocene to the middle Eocene. Though the Unit II was divided into Units IIA and Unit IIB on several cases in the above area of the Central Pacific Basin, the two subunits are not distinguished in the Penrhyn Basin of this area.

Figure II-3 shows the seismic profiles during the cruise.

The transparent layer of the Unit I in the basin area to the west of the trough is

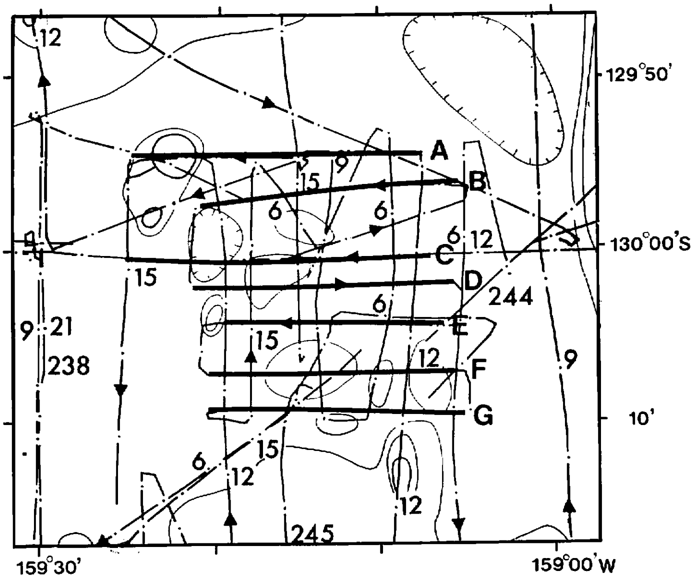


Fig. II-2 Track lines of air gun seismic survey of Cruise GH83-3 (detailed survey). Bold letters from A to G denote numbers of survey lines.

presumably of Eocene or Oligocene to Quaternary in age with maximum thickness of 0.5 seconds in two-way travel time. But the Unit I is hardly distinguished on seismic profiles in most part.

In the detailed surveyed area, the transparent layers correlatable to the Unit I generally develop concordantly with the smooth morphology of the surface of the basement, with the maximum thickness of 0.05 seconds in the eastern part which is significantly greater than that in the western part. Though the basement morphology is irregular in some places due to existence of several small basement knolls elongated almost in N-S direction, the transparent layers are frequently absent near the flank of the knolls and faults, which suggests the erosion by strong bottom currents.

The Unit II on seismic reflection profiles shows opaque to semi-opaque acoustic features in general. In some places, it possibly includes overlying Quaternary turbidites with flat surface. But the Unit II with acoustic scattering patterns in the surveyed area suggests the existence of volcanic rocks, and the strong reflectors could be correlated to chert or cherty chalk of the early Oligocene in the drill cores at DSDP Site 316 in Line Islands area and Site 318 (Winterer, E. L., Ewing, J. I. *et al*., 1973). Therefore, the age of the Unit II is presumably early Oligocene or older.

Geological Structure

The Penrhyn Basin is generally characterized by slightly irregular topography between 5,200 and 5,300 m in water depth, and the greater depths are encountered in the faulted depressions (Mizuno and Okuda,1982). The data of bathymetric and seismic reflection survey during the GH 83-3 cruise clarified that a major elongated trough runs in N-S to N30°W-S30°E in the eastern-central part of the survey area, and

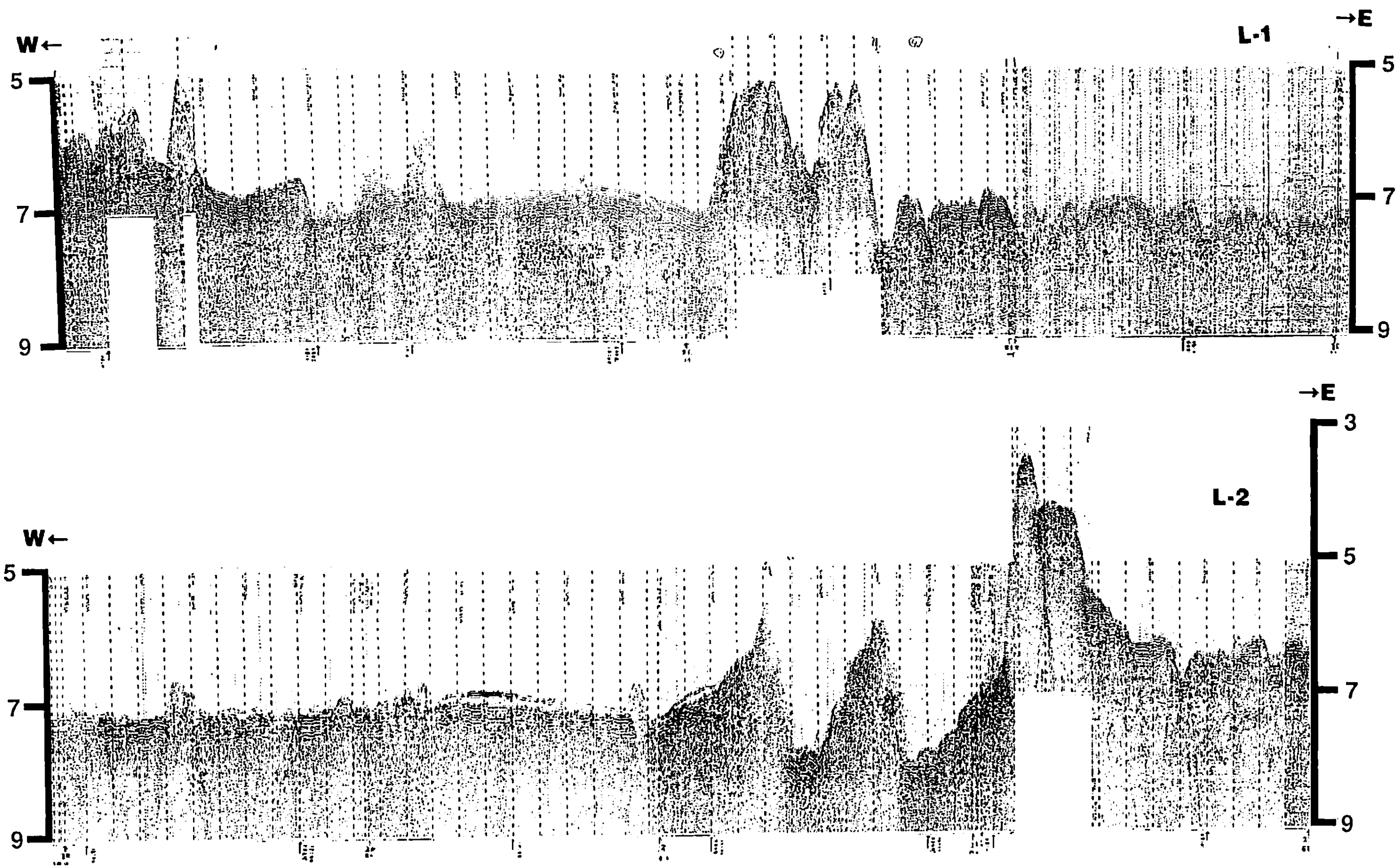


Fig. II-3 Seismic profiles over the GH83-3 area. See in Fig. II-1 for line numbers.

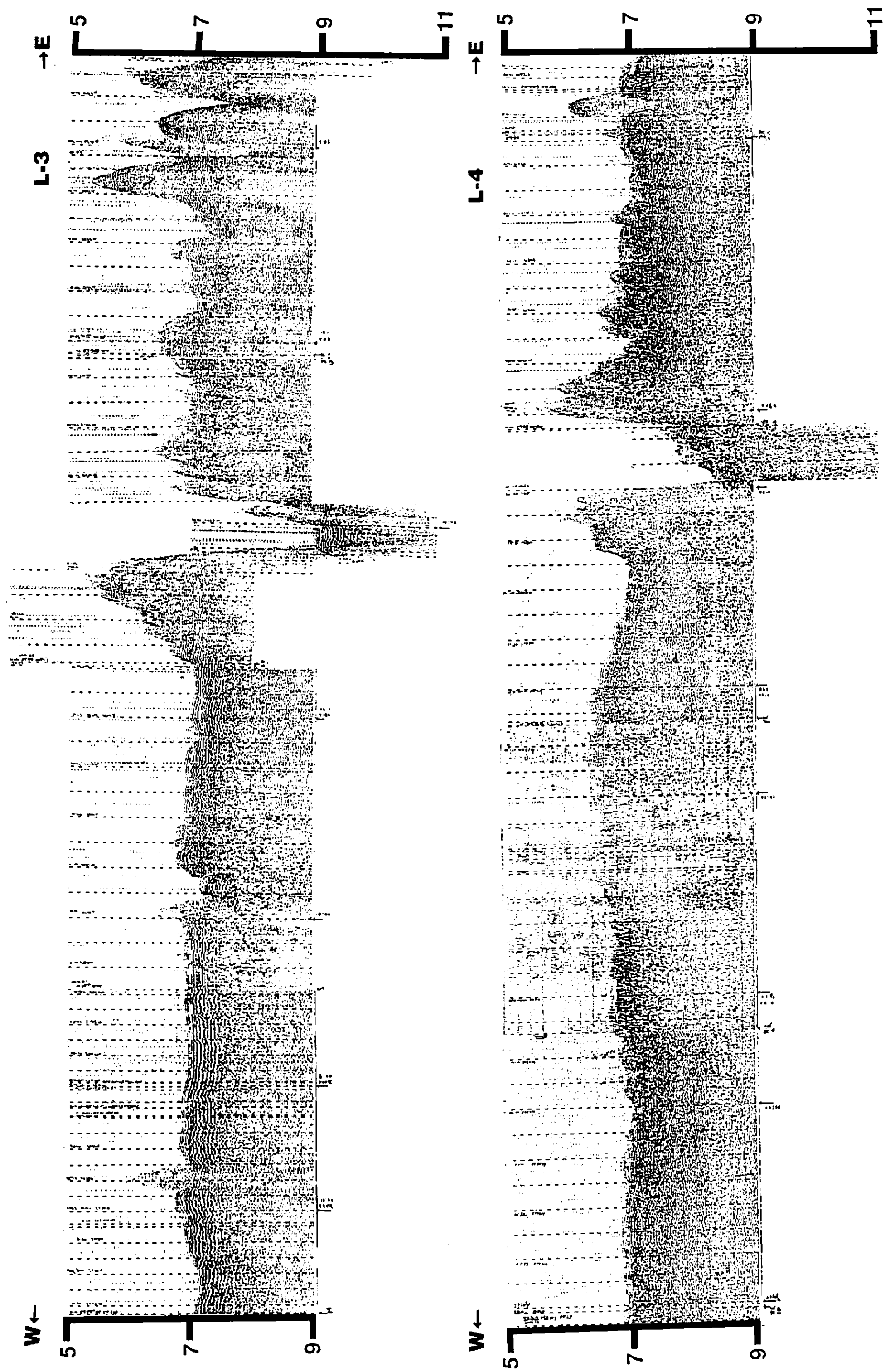
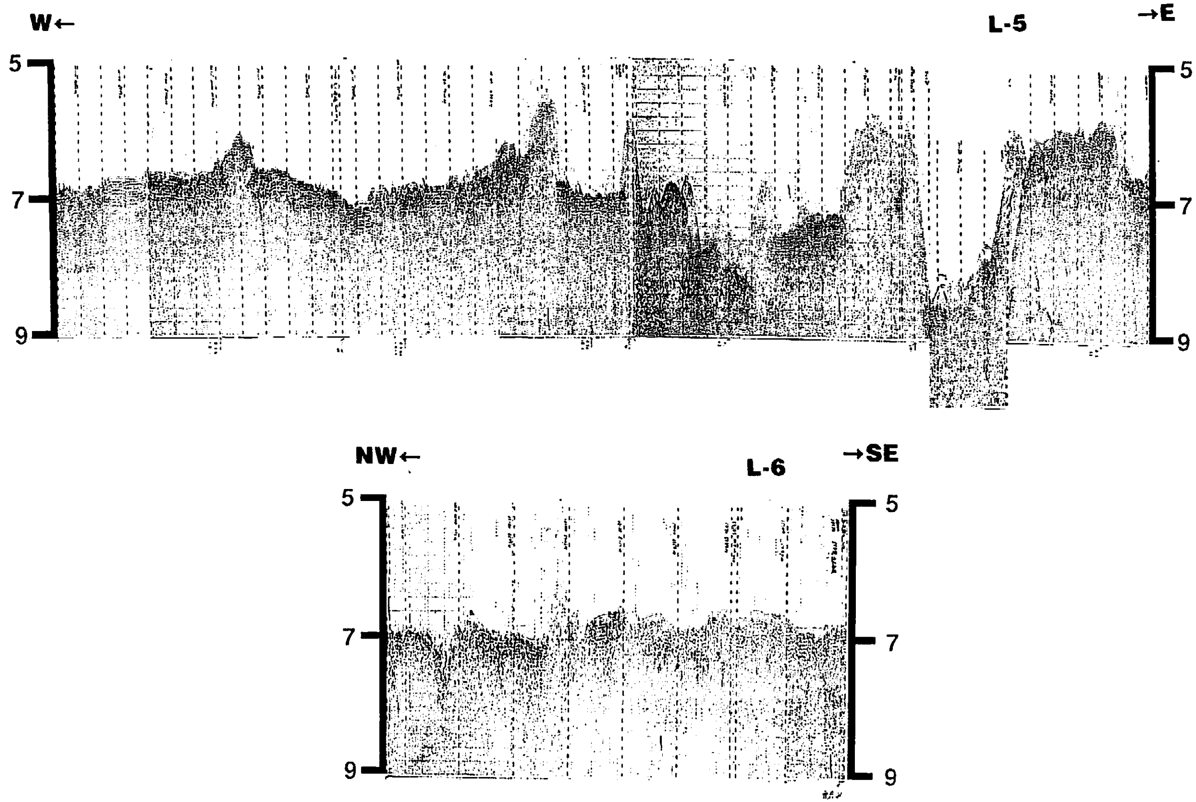


Fig. II-3 (continued)



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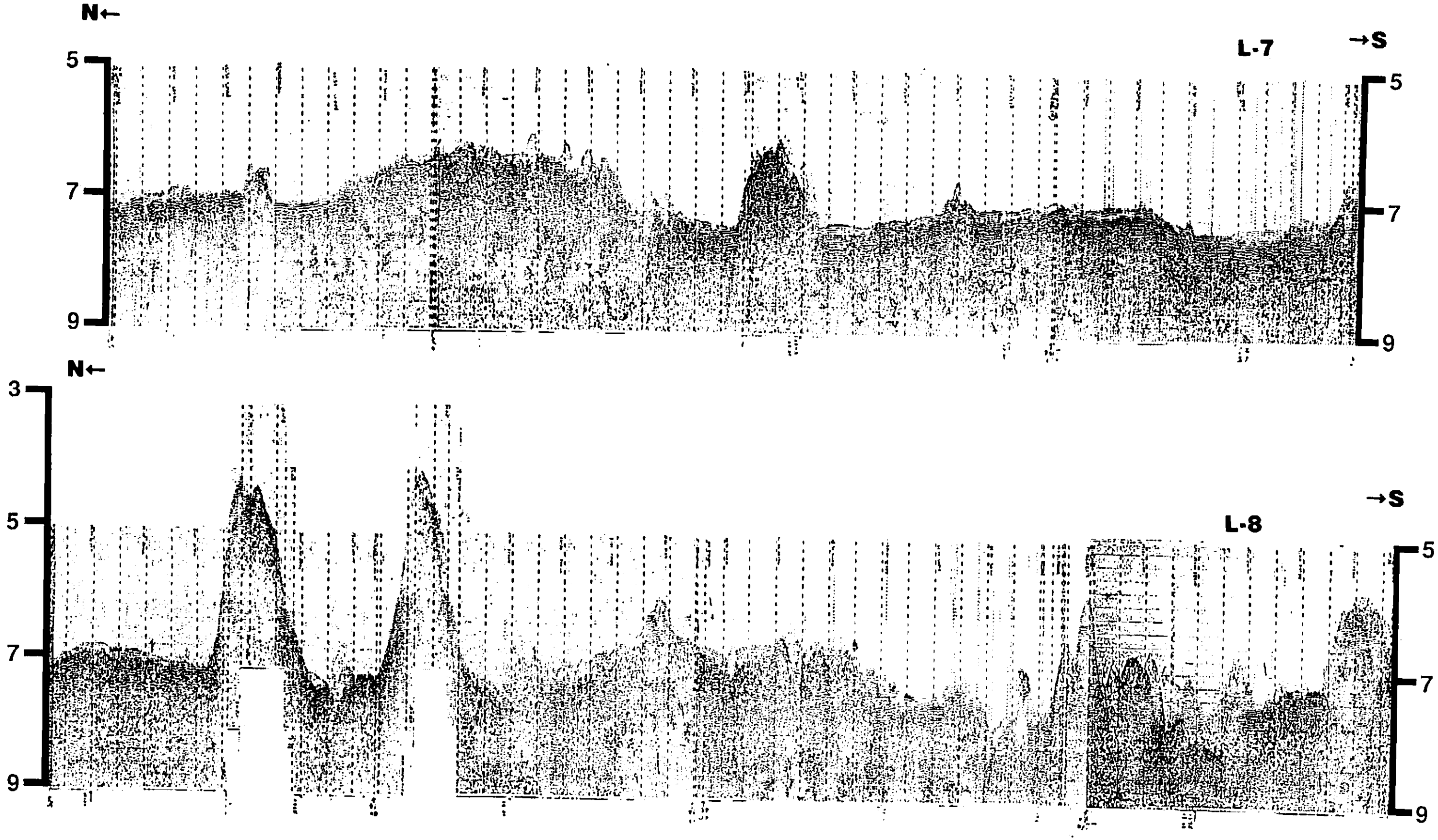

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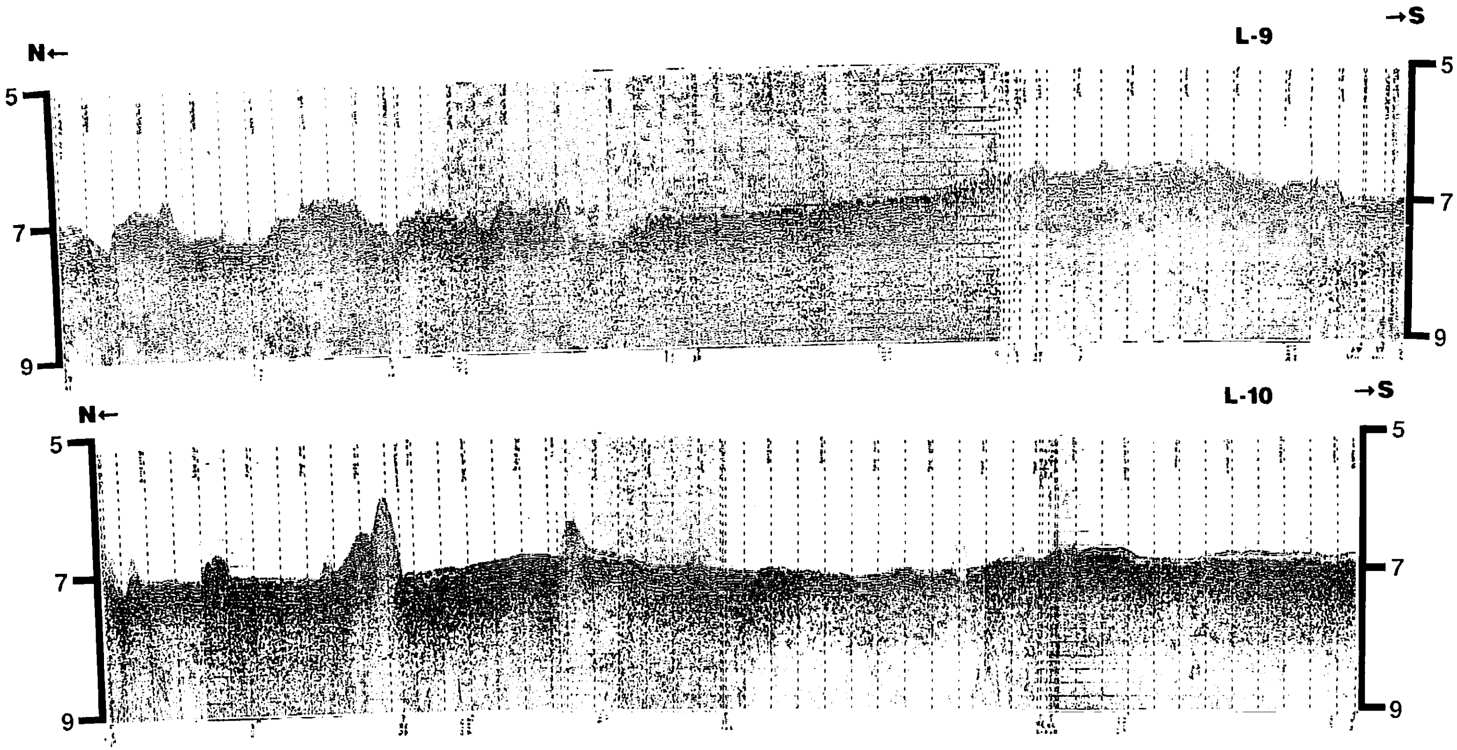

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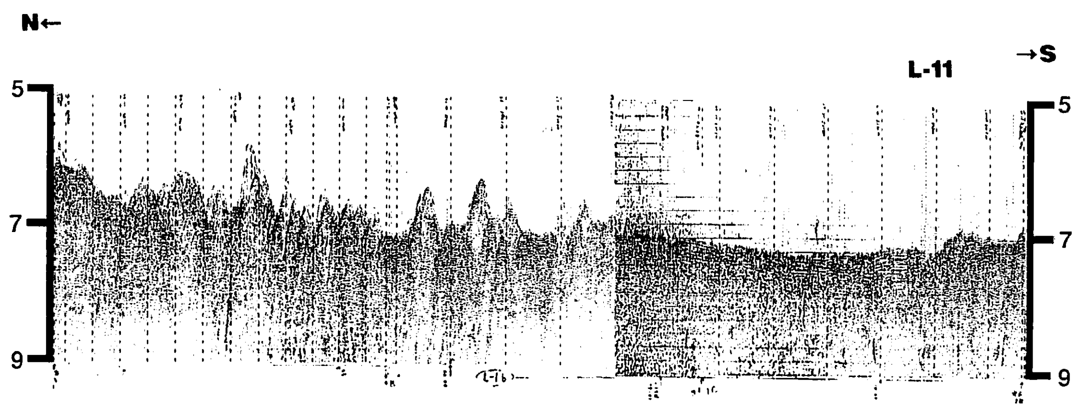

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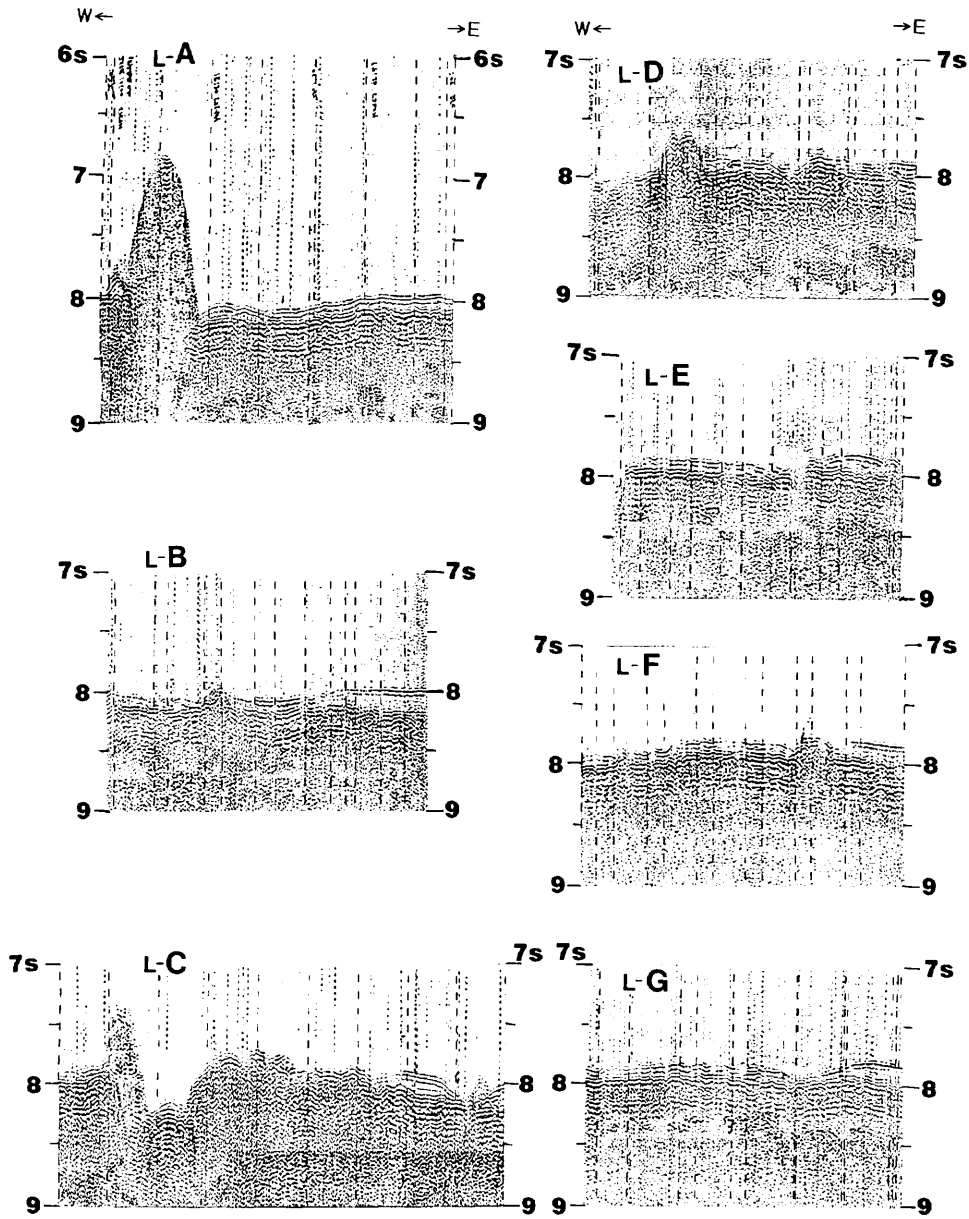

Fig. II-4 Seismic profiles over the detailed survey area. See in Fig. II-2 for line numbers.

binds the two characteristic geologic provinces. The difference in average water depth and the morphology of acoustic basements between the eastern and the western areas suggests that the age of the basement and subsequent sedimentary conditions could be different. Seismic reflection profiles in the detailed surveyed area are shown in Figure II-4.

Seismic reflection profiles in the detailed surveyed (Fig. II-4) reveals that the transparent layer of Unit I has deposited generally concordantly with the basement where the surface of basement is smooth, and the thickness of the layer is generally greater in the eastern part than that in the western part. When the basement morphology is irregular due to the scattered distribution of several small basement knolls elongated almost in N-S direction, the transparent layers are often absent near the flank of the knolls and scarps. Therefore, strong bottom currents may have affected the subsurface geologic structure in this area.

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