VI. CONTINUOUS SEISMIC REFLECTION PROFILING SURVEY

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Continuous seismic reflection measurements were carried out along the ship's tracks shown in Fig. I-2. Two sound sources were used during the present survey. The main sound source was a BOLT PAR 1900B air gun with 120-cubic inches (1980 cm^3) firing chamber operated at a pressure of 1700 p.s.i. (approximately 115 kg/cm^3) with a firing interval of 12-seconds (Line 1 to 30) or 13-seconds (Line 31 to 45). Another supplementary sound source was a sparker (NE 17-B Geo Sonar) operated at the energy of 10,000 joules with a firing interval of every 12-seconds. Seismic signals were detected by a Teledyne Hydrostreamer with 50 crystal hydrophones, a GSJ hydrophone array with 50 crystal hydrophones (Geo Space MP 17) or a NEC hydrophone array with 30 crystal hydrophones (Geo Space MP 17) towed 150 m behind the ship. When the air gun was used as a sound source, the signals were processed through a Teledyne Model Au-220 amplifier system with filters passing generally 31–98 Hz, and fed into a Raytheon Universal Graphic Recorder Model 196–B employing a 4-sec sweep rate. When the sparker was used, the signals were processed through a NE 17-B Geo Sonar amplifier system with a filter setting of 100–300 Hz, and recorded on a Raytheon Universal Graphic Recorder Model 196-C operated at a 2-sec sweep rate. Almost all of the tracks were surveyed by the air gun seismic profiler system and only two tracks (Line 2 and 3) were partialy surveyed by the sparker seismic profiler system. The ship's speed was maintained at 11-knots except for the special case of Line 17′, 17″, 18′, 18″, 19′ and 19″ (8–9 knots).

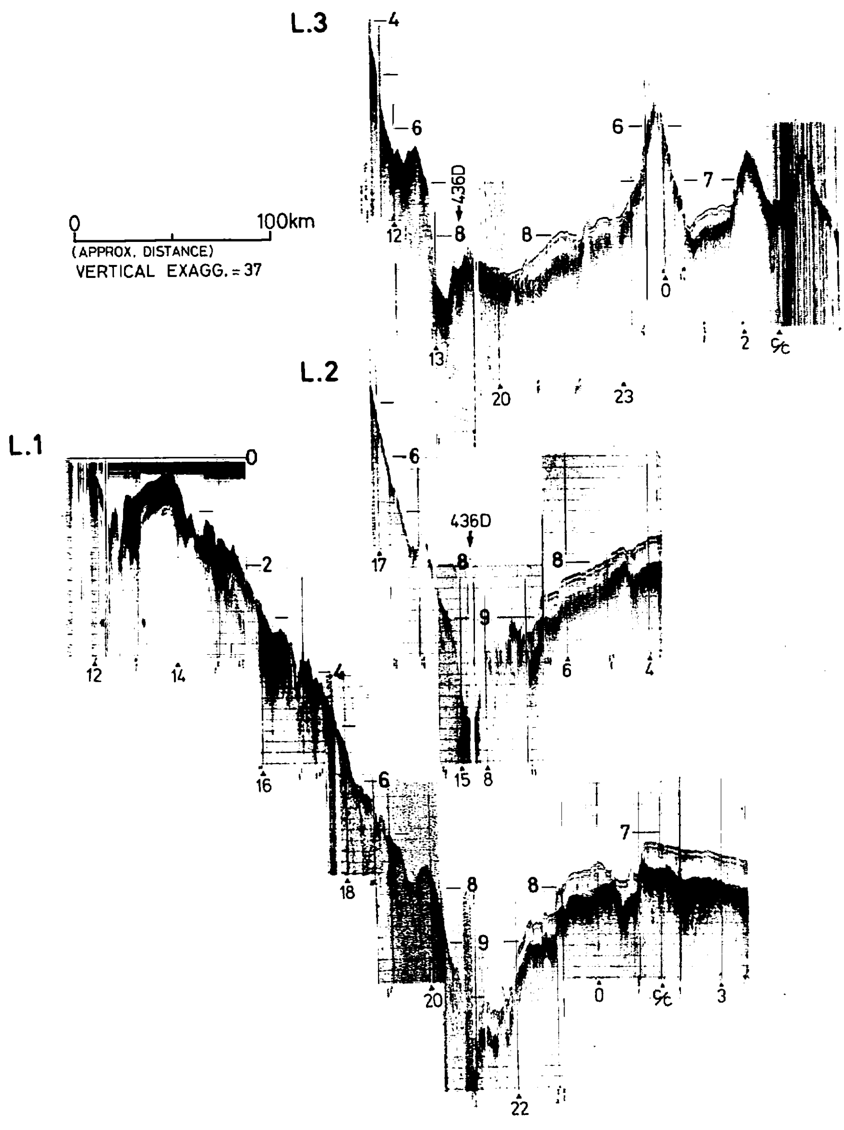
All the profiles obtained during the present cruise are shown in Fig. VI-1, and the prominent features on the seismic profiles are illustrated in Fig. VI-2 with enlargement of the profiles. The depth on the seismic profile records is in second of two-way acoustic travel time and the thickness of sediments in interpreting the profiles is also presented in two-way travel time because of the uncertainity of the sonic velocity of the sediments.

The nomenclature defined by Honza and others (in prep.) is used for the topographyic units in the surveyed area–frontal arc system. Namely, the continental shelf, the continental slope, the trench slope break, the inner trench slope, the trench, the outer trench slope and the oceanic floor are used in interpreting the profiles.

Continental Shelf and Continental Slope along the Japan Trench

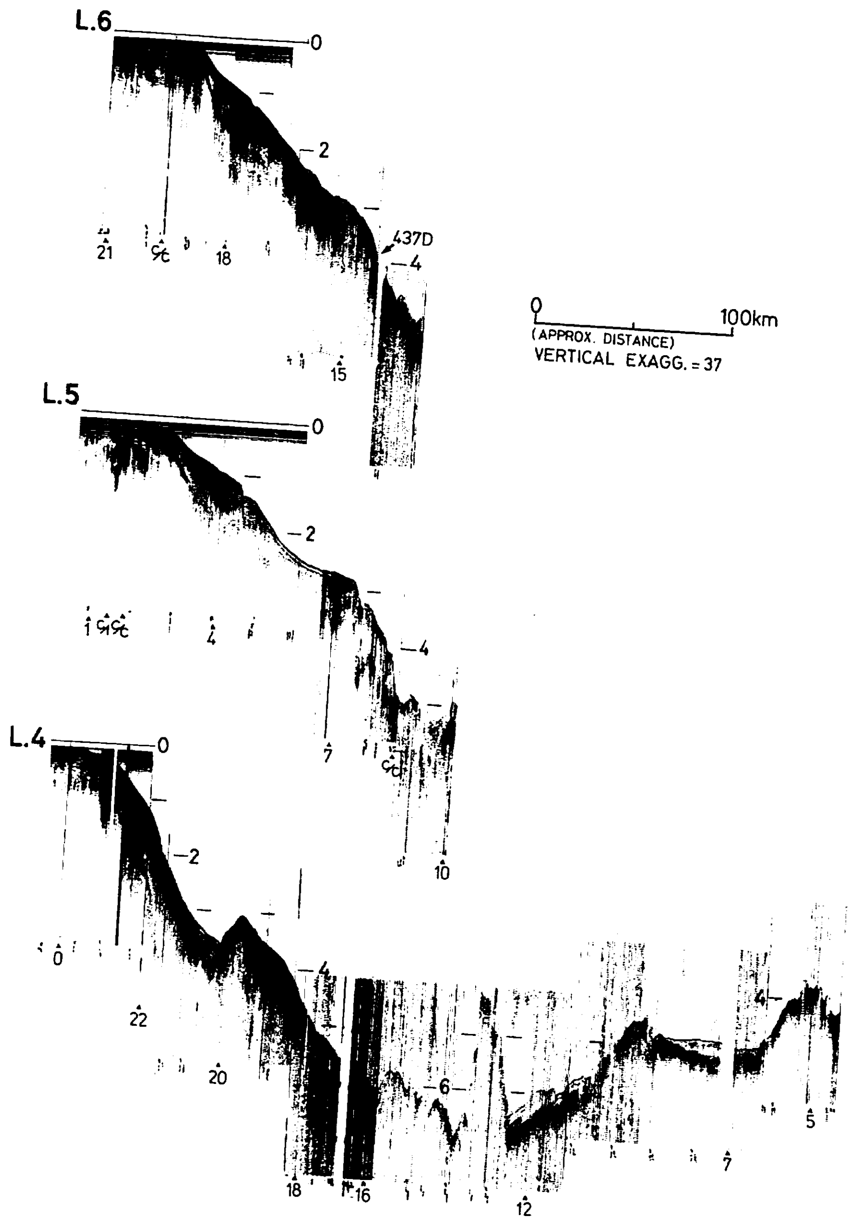
The continental slope in this area is divided into the upper continental slope and the lower continental slope by the presence of the change in slope decline. The upper continental slope is steeper than the lower continental slope and the lower continental slope is nearly flat in the northern area (profiles 20–25).

Sediments with a maximam thickness of more than 2.0 seconds, are present on the continental slope and the sediments are acoustically highly reflective. The sediments on the continental slope are generally divided into four layers (Fig. VI-2). The upper layer is undeformed and unconformably overlies the middle layer which is markedly

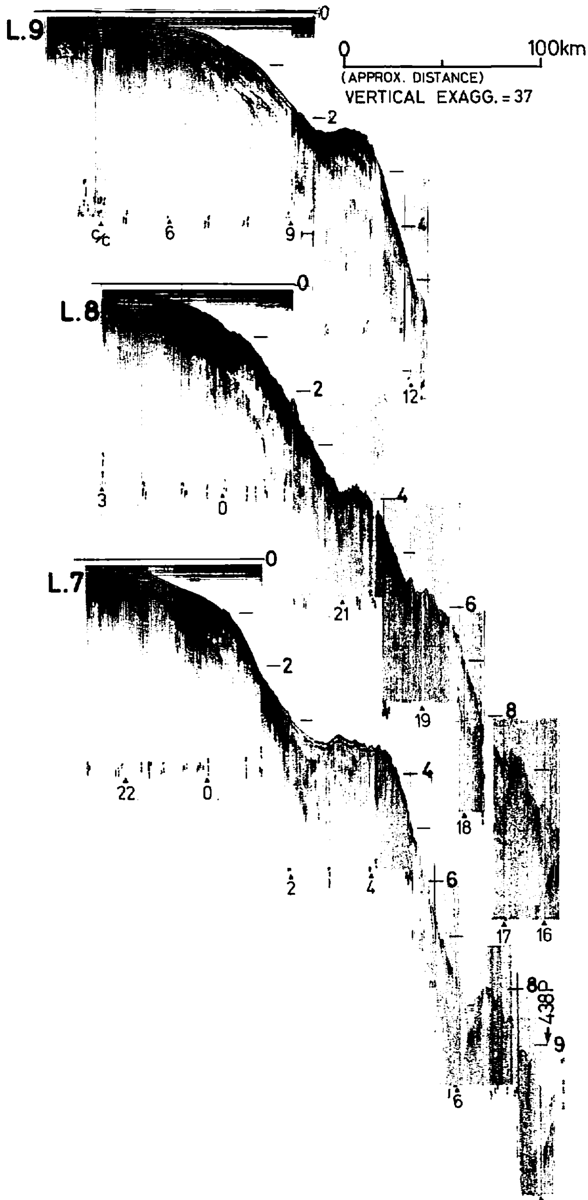


(A)

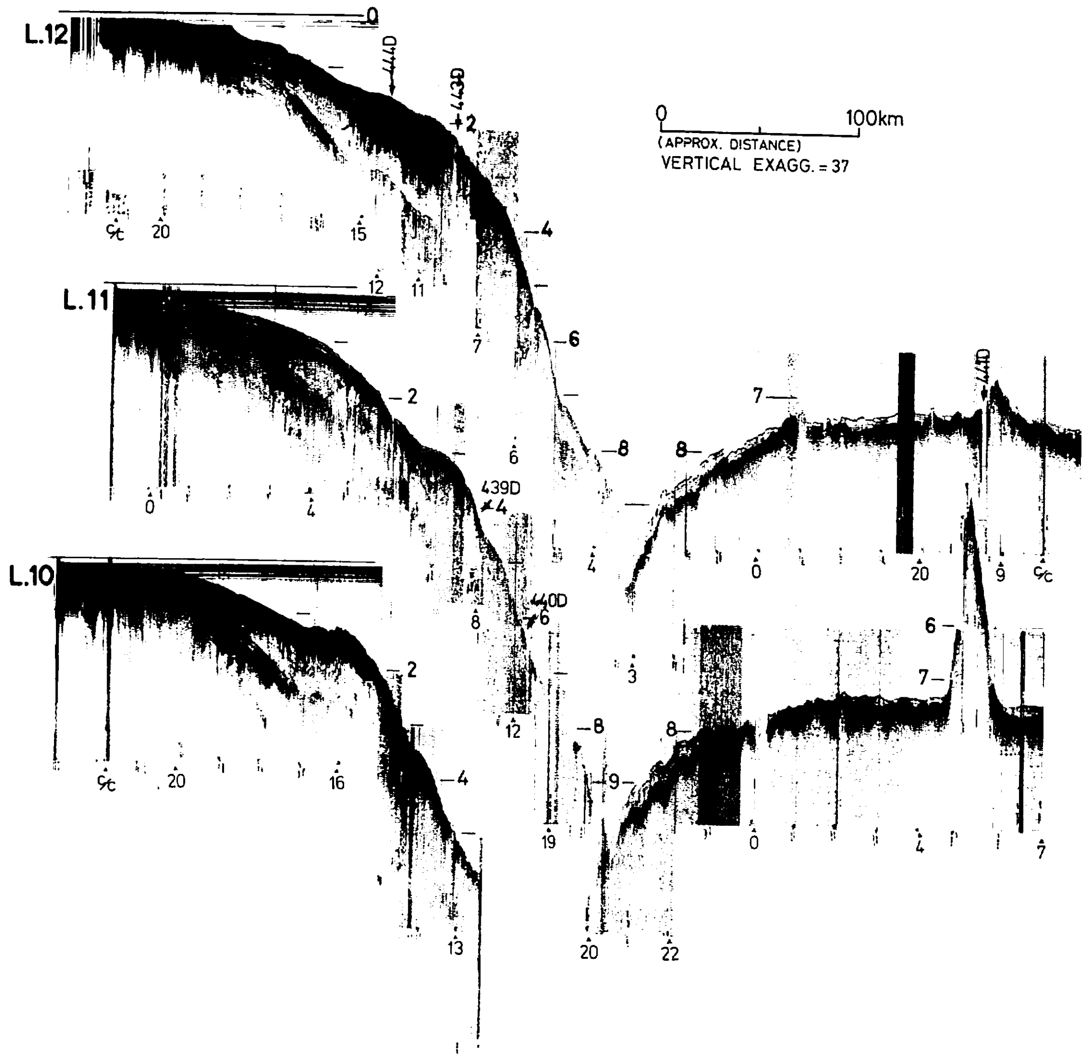
Fig. VI-1 Continuous seismic profiling records with surveyed line numbers shown in Fig. I-1. Vertical scale is presented in seconds of two-way travel time. The bottoms of the profiles are annotated with the times in hours and the event of course changes.



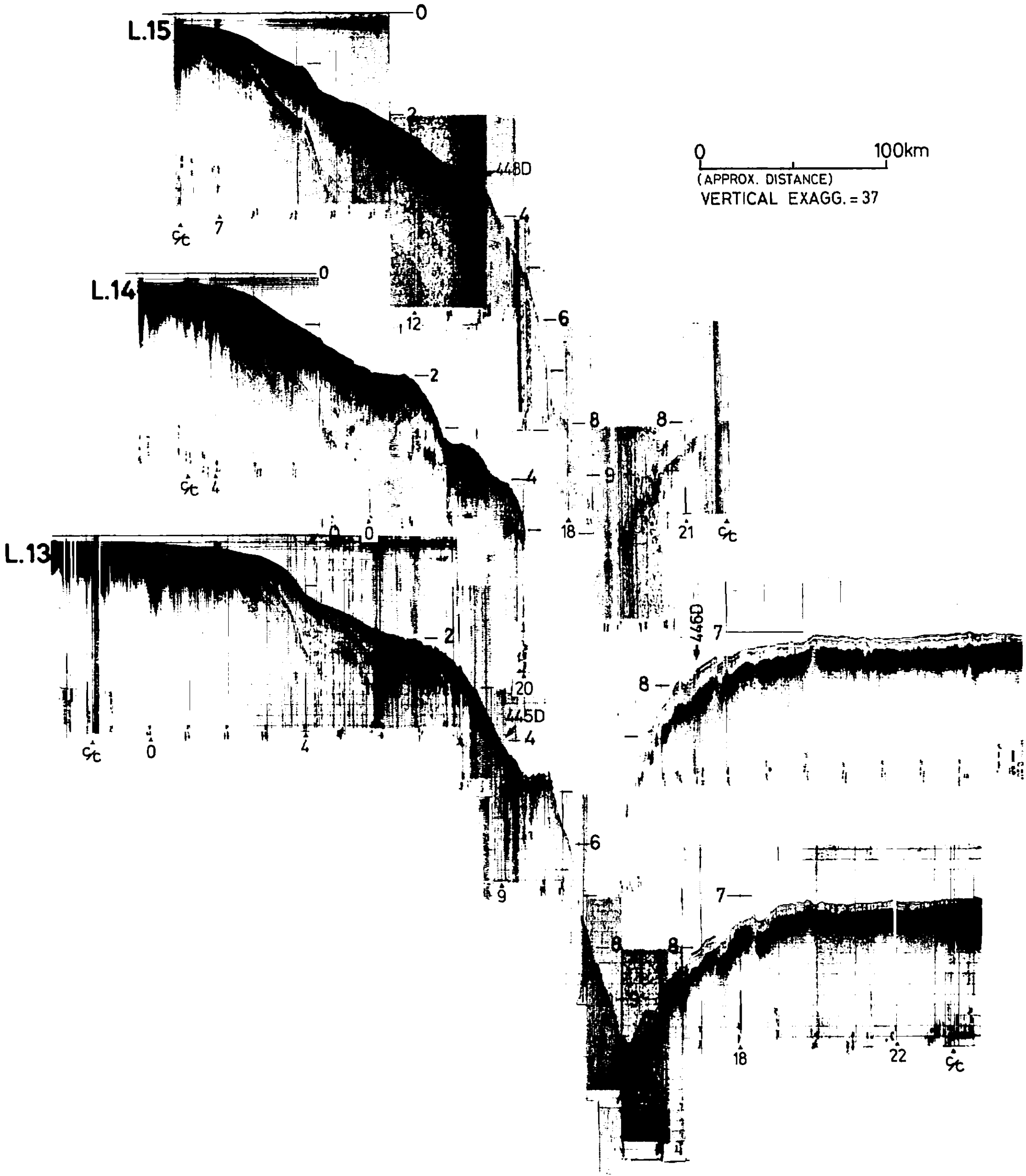
(B)



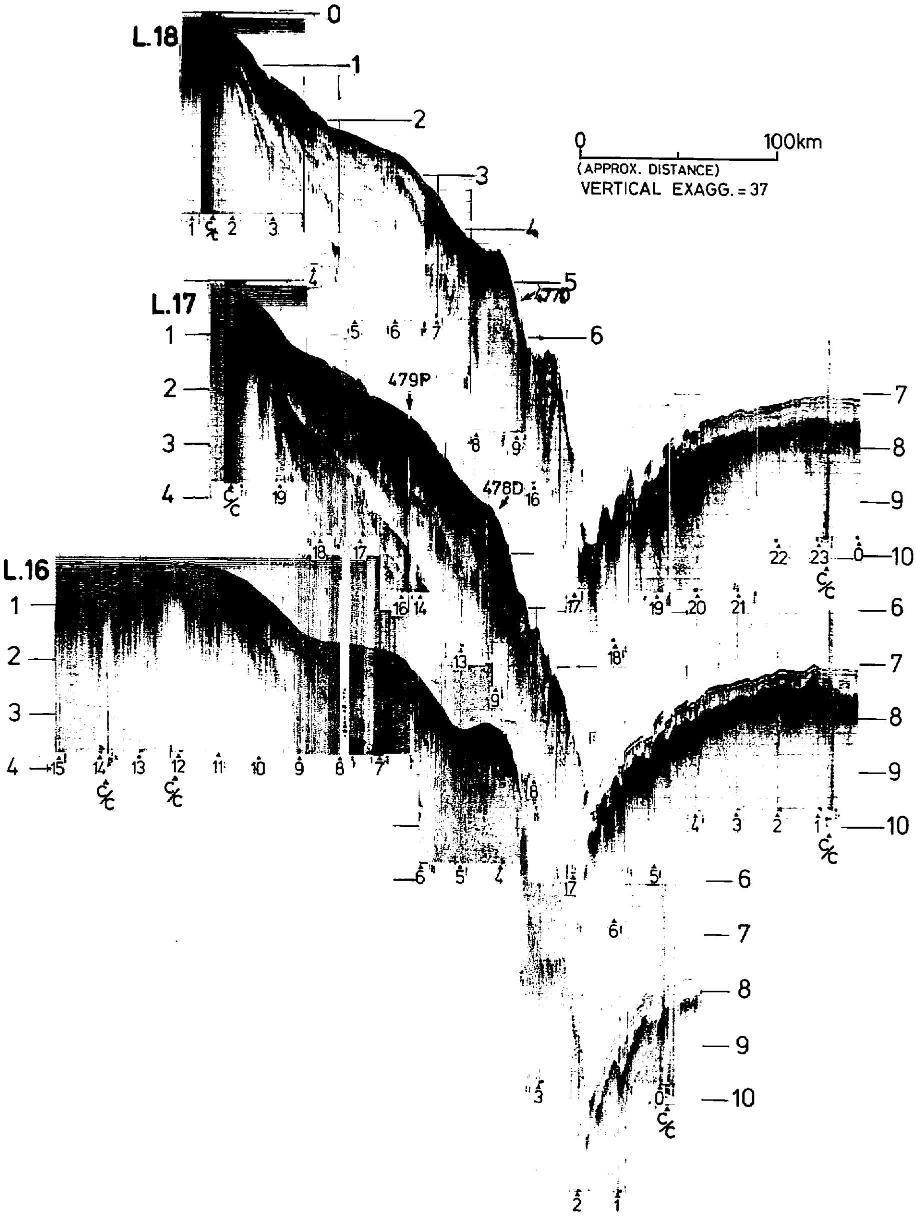
(C)


L.12
L.11
L.10
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37
440D
439D
440D
439D
440D

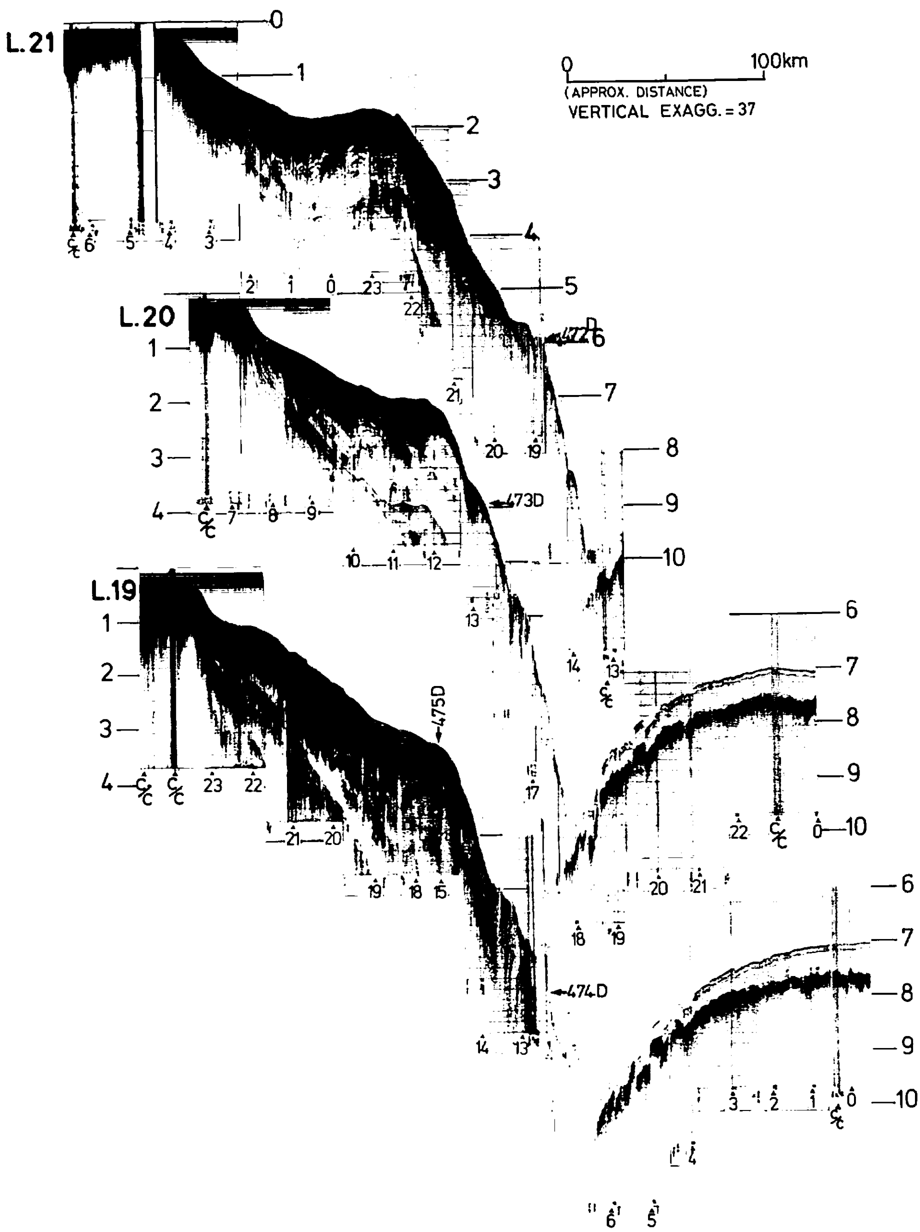
(D)


L.15
L.14
L.13
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37
448D
446D
445D

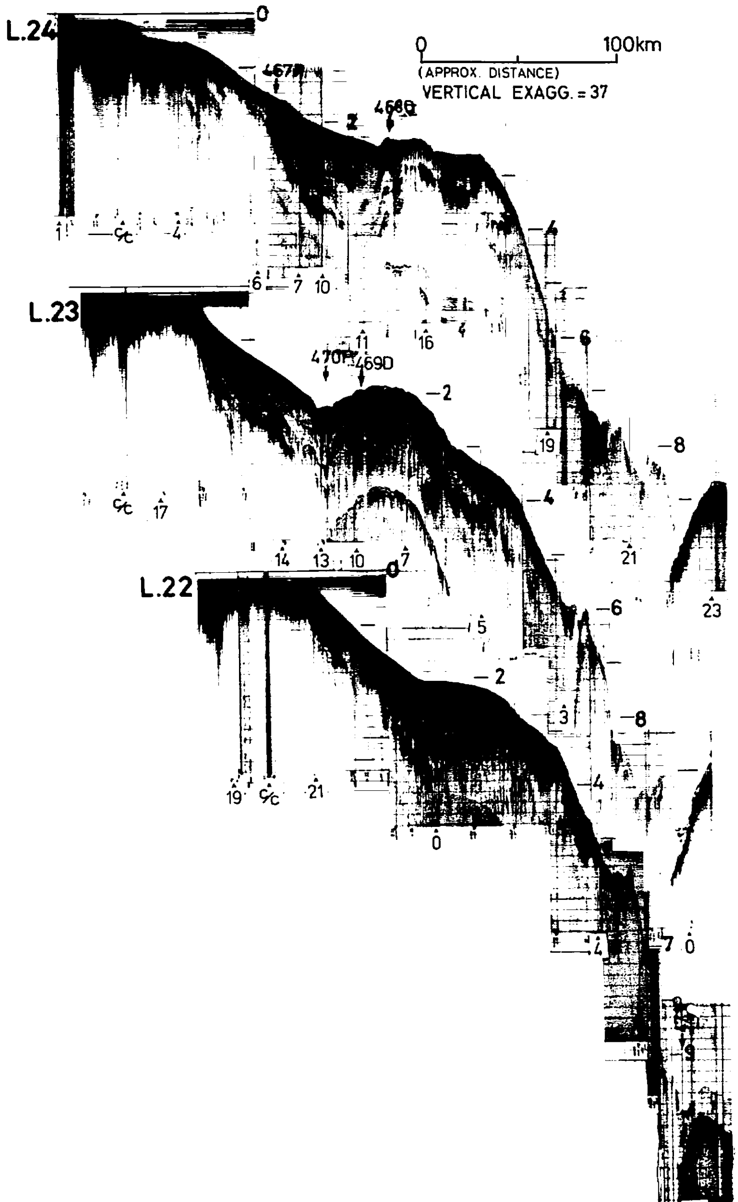
(E)


L.18
L.17
L.16
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37
479P
478D
477D

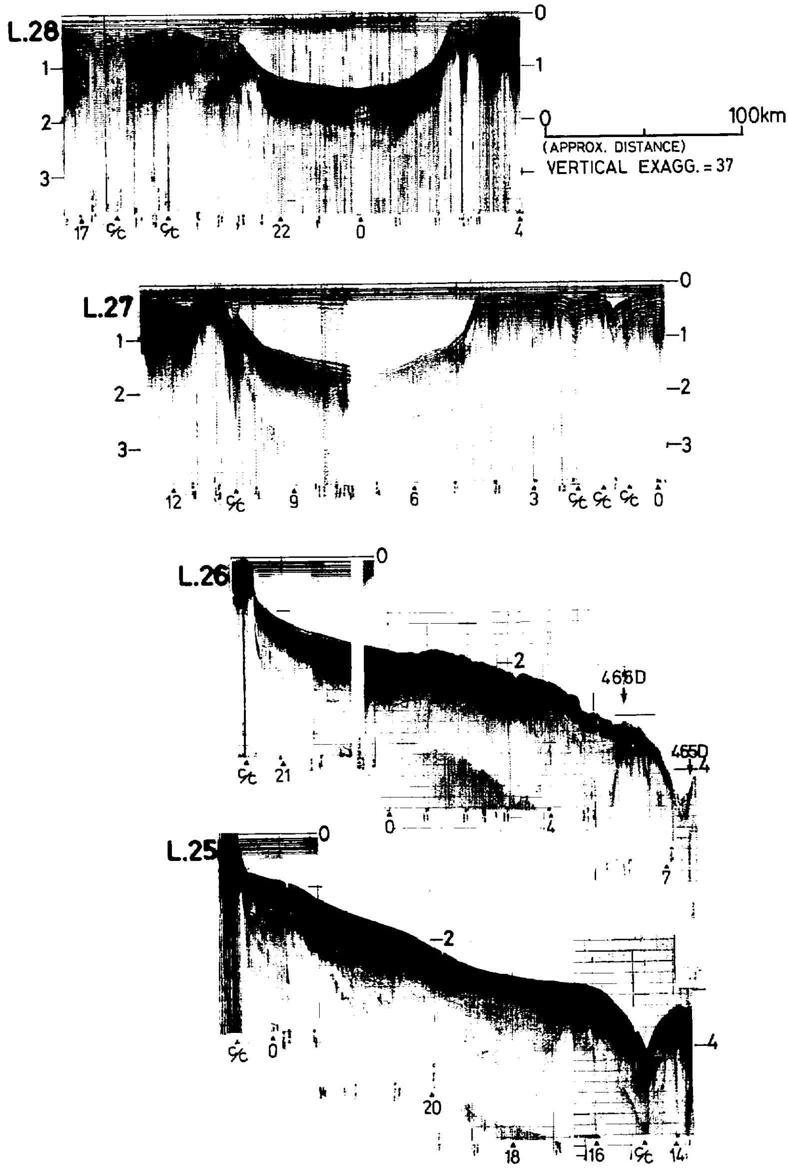
(F)


L.21
L.20
L.19
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37
473D
475D
474D

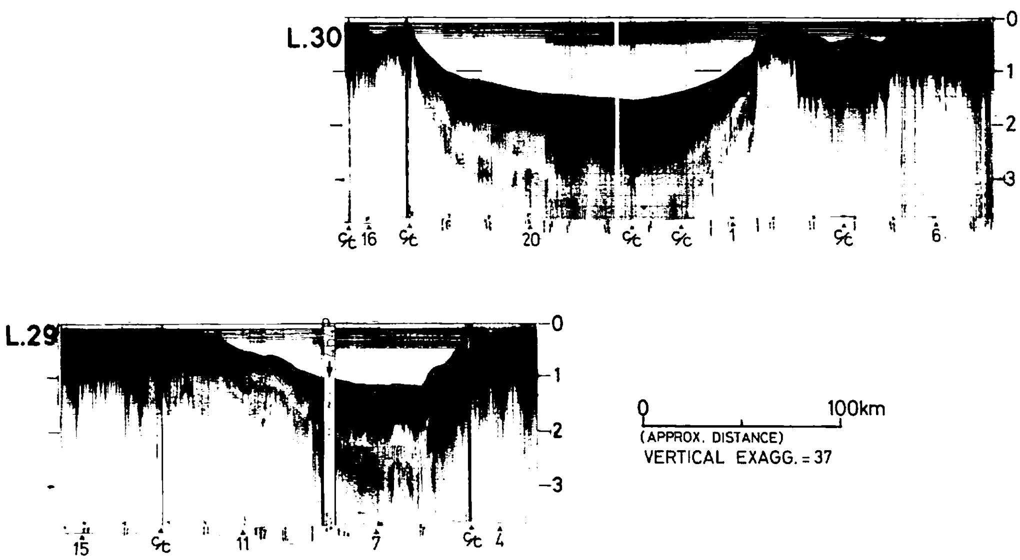
(G)


L.24
L.23
L.22
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37
467
468D
470
469D
–2
–4
–6
–8

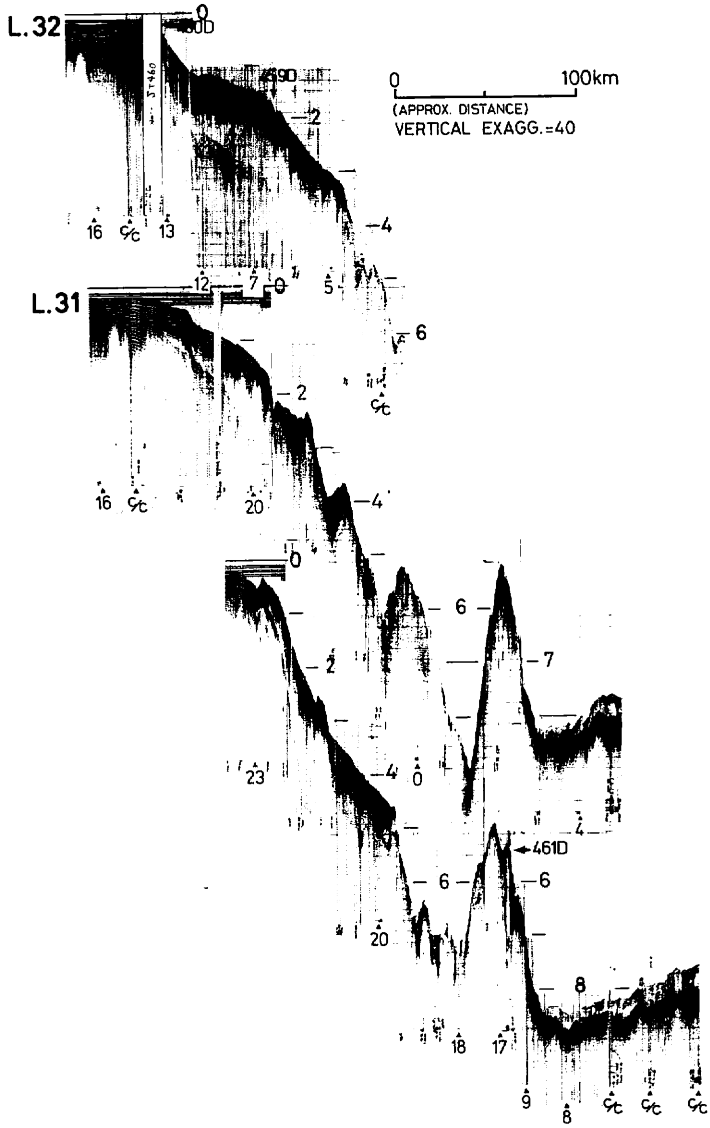
(H)


L.28
L.27
L.26
L.25
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37
465D
466D

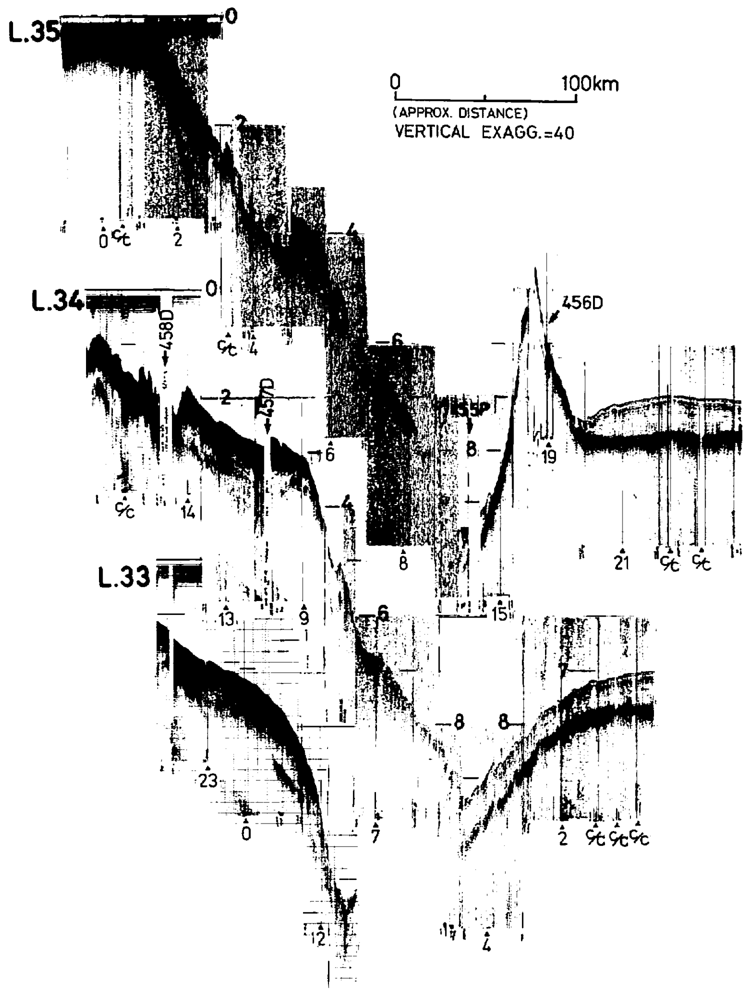
(I)


L.30
0
1
2
3
16
20
1
6
L.29
15
11
7
4
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37

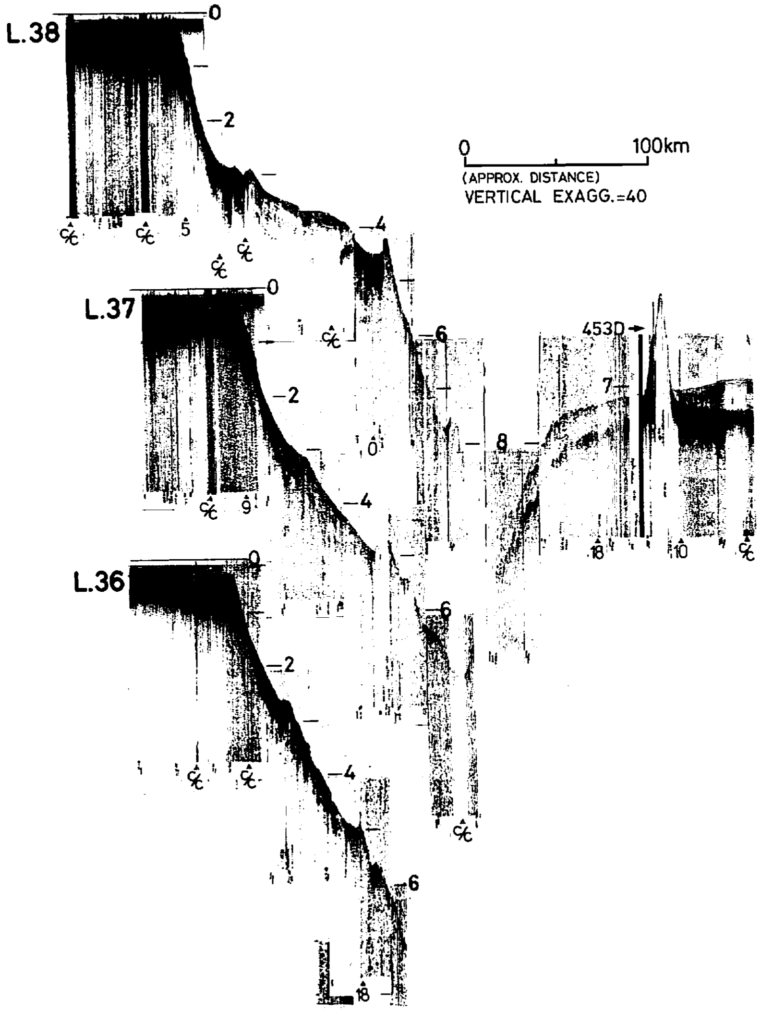
(J)



(K)

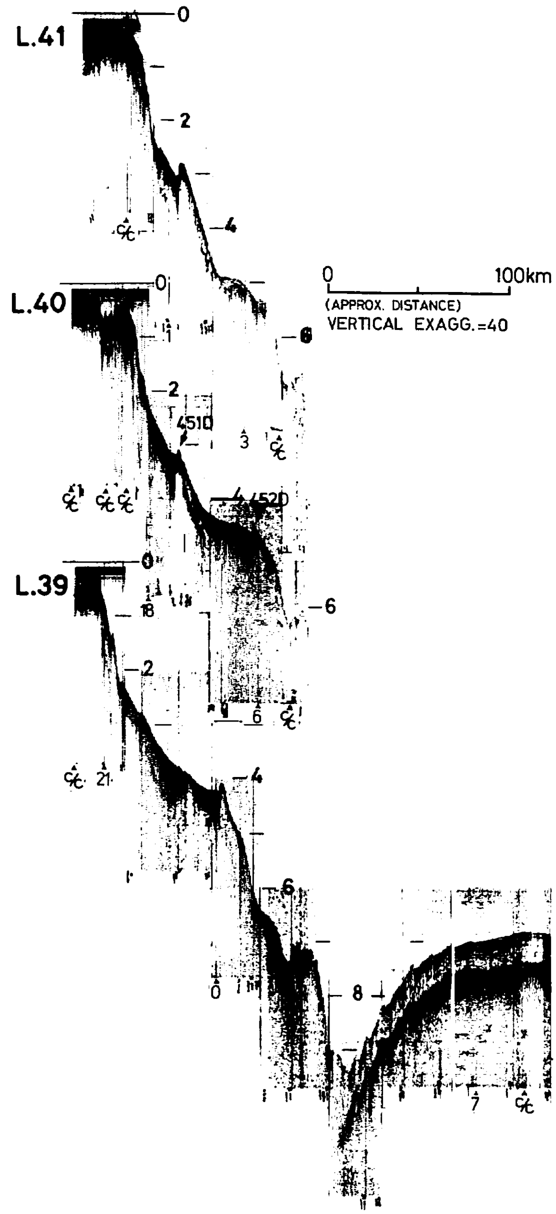

L.35
L.34
L.33
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG.=40
458D
457D
456D
455P
19
21
14
13
9
8
15
23
12
7
4

(L)

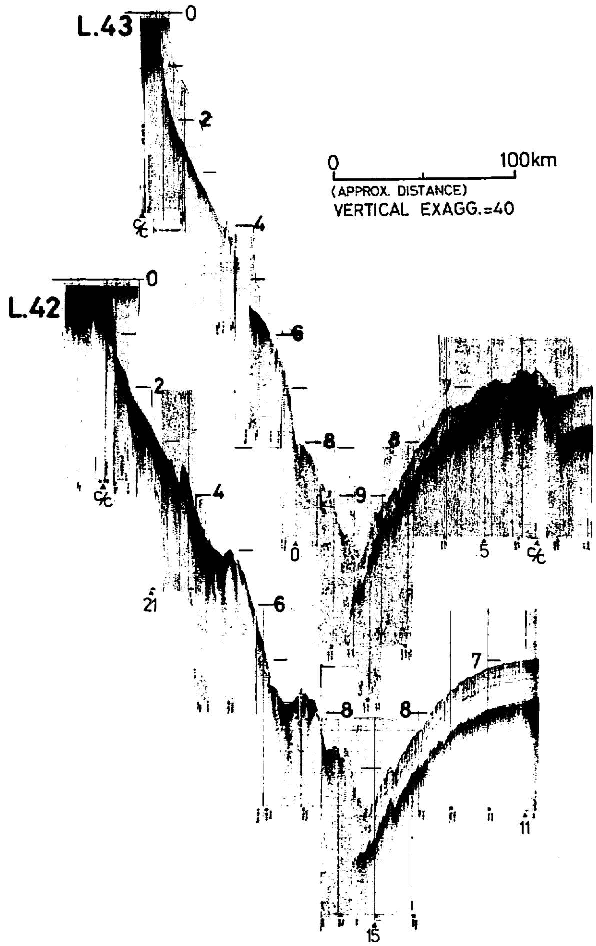


L.38
L.37
L.36
0
2
4
6
7
8
5
9
10
18
453D
0 100km
(APPROX. DISTANCE)
VERTICAL EXAGG.=40

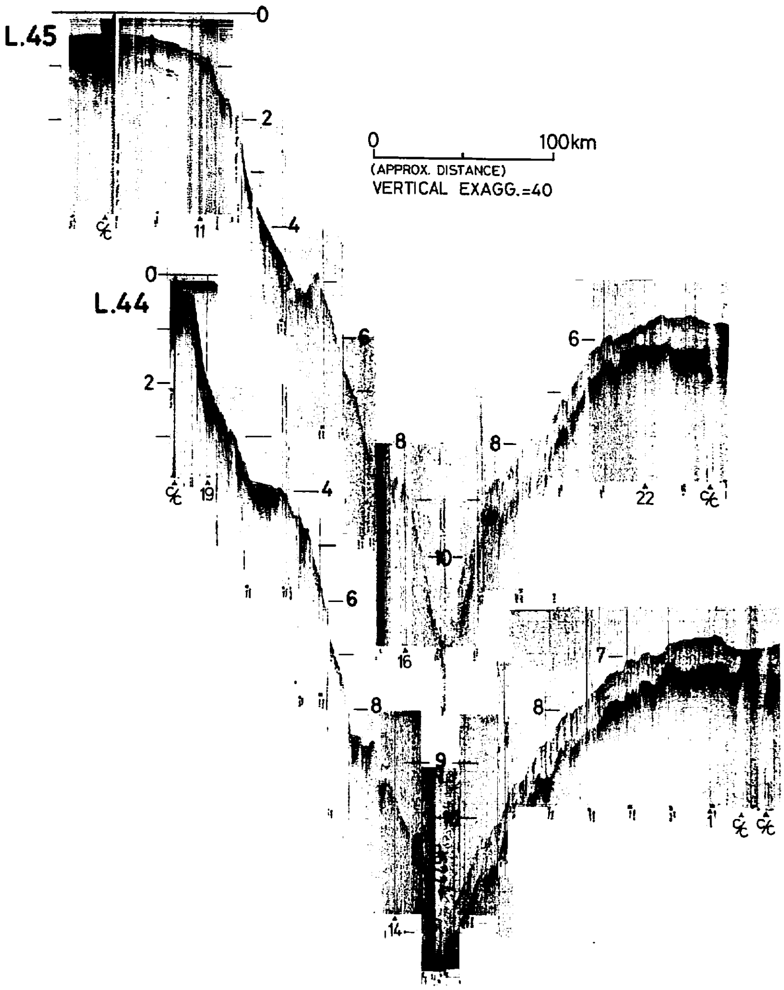
(M)


L.41
L.40
L.39
0
100km
(APPROX. DISTANCE)
VERTICAL EXAGG.=40
4510
4520

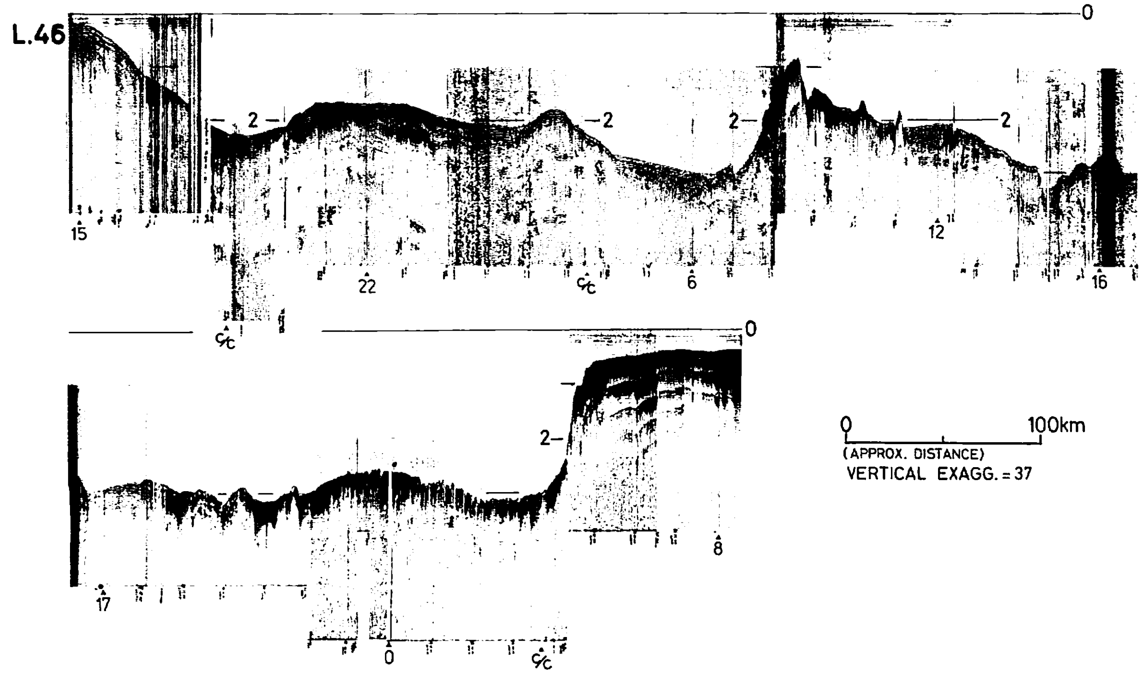
(N)



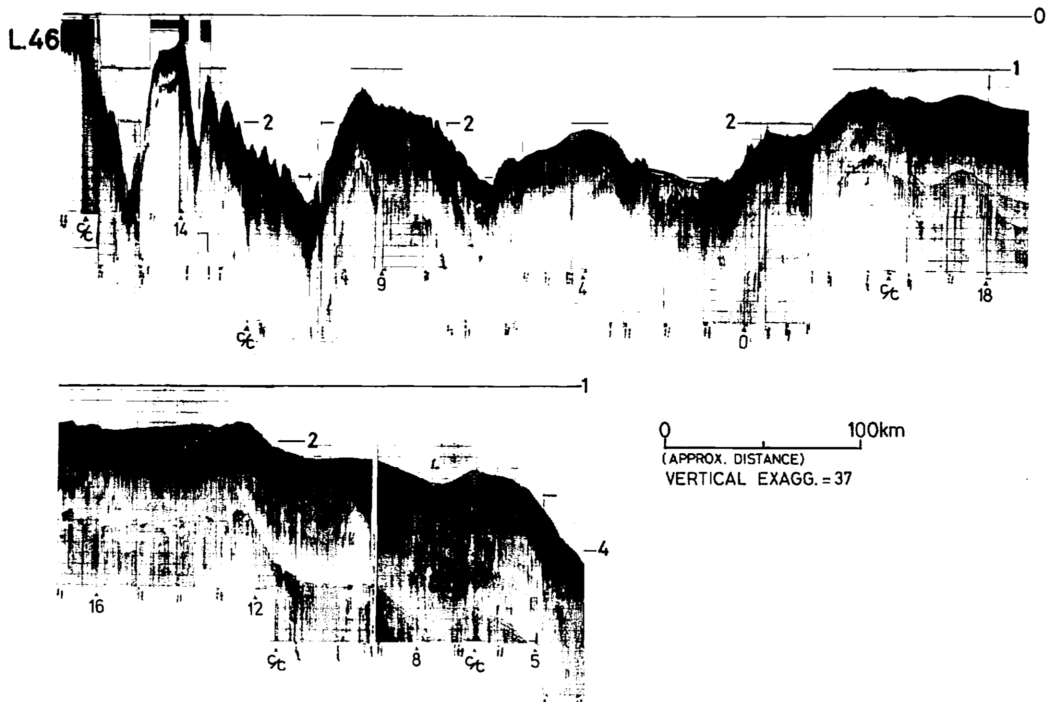
(O)



(P)


L.46
0
2
15
22
6
12
16
17
8
0
0 100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37

(Q)


L.46
0
1
2
4
14
9
4
0
18
16
12
8
5
0 100km
(APPROX. DISTANCE)
VERTICAL EXAGG. = 37

(R)

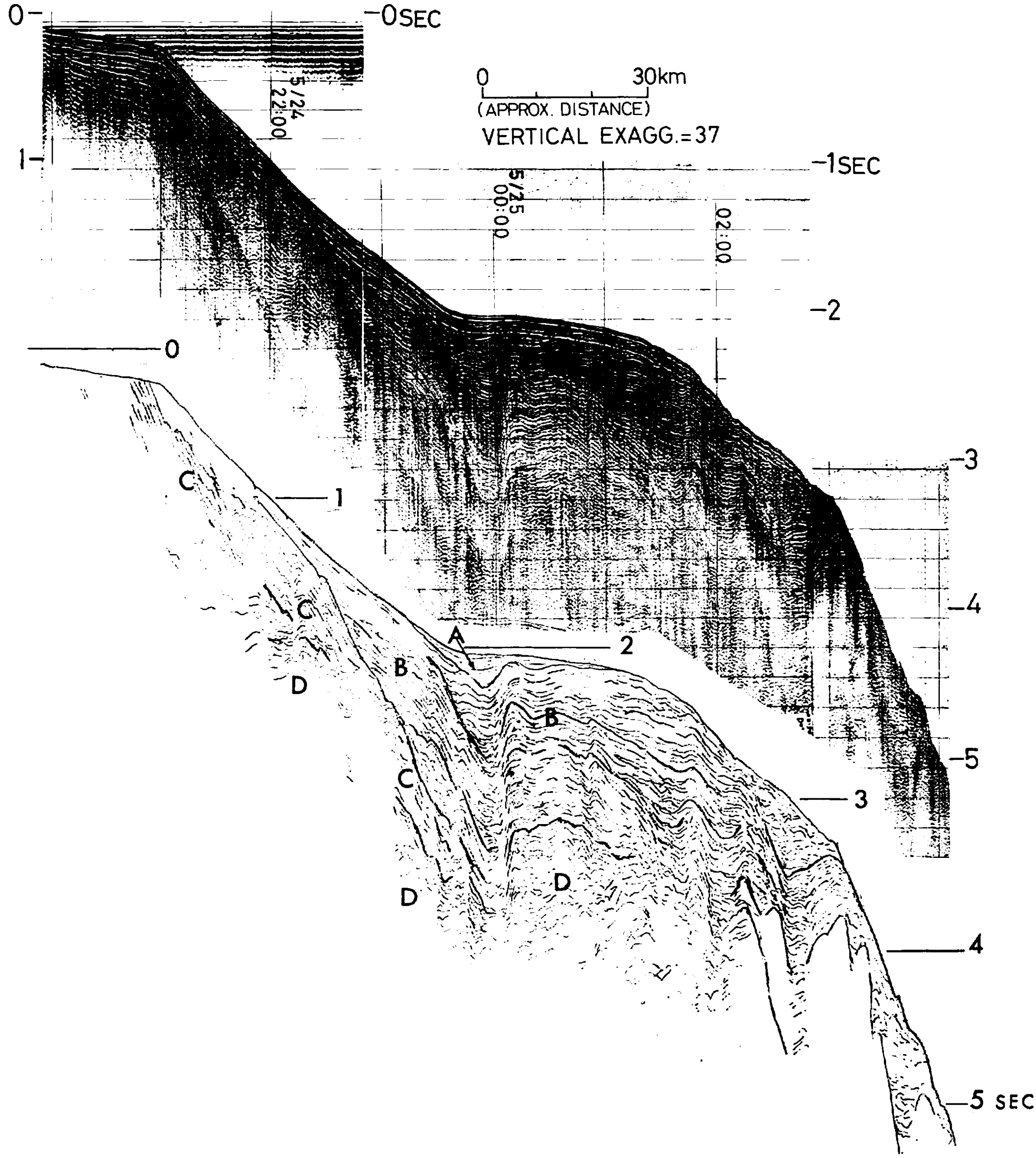


Fig. VI-2 A continuous seismic profiling record with line drawing on the continental shelf and continental slope along the line No. 22, with annotation of the time in days and hours. Vertical scale is presented in seconds of two-way travel time. A: the upper layer, B: the middle layer and C: the lower layer in this chapter.

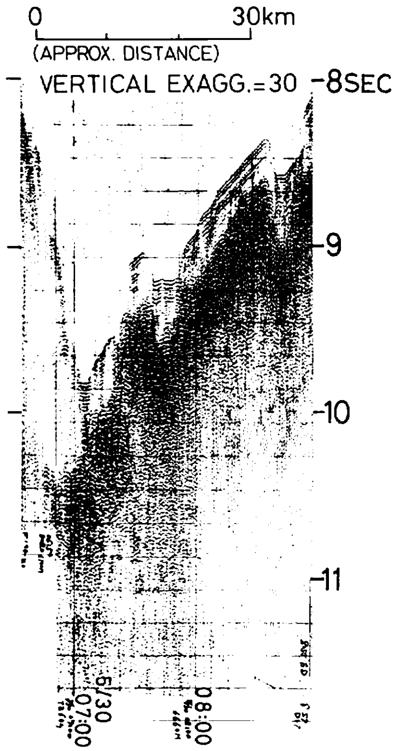


Fig. VI-3 A continuous seismic profiling record showing the conspicuous displacements on the outer trench slope along the line No. 17′. Vertical scale is presented in seconds of two-way travel time. The bottom of the profile is annotated with the times in day and hours.

folded. The upper layer is distributed only on the lower continental slope and the thickness is much thinner than of the other layers. So, it represents a simple sedimentary cover. The deformed middle layer crops out on the upper continental slope, and, abuts and overlaps onto the lower layer to the landward side of the slope. The lower two layers extends upward to the continental shelf and occur on the continental shelf. The lowermost layer forms a conspicuous syncline below the continental shelf in the southern area (profiles 8, 9 and 10). In profiles 10, 11 and 12, the shelf edge consists of gently monoclinically dipping layers twords the ocean basin.

The seaward continuation of these layers is varied. In a few profiles, the second layer crops out on the trench slope break (profiles 21 and 22). In several profiles, the height of the lowest layer consists of the trench slope break (profiles 10, 13, 14, 15, 19 and 20) and other complicated features are observed at the trench slope break. This sedimentary sequence extends into the basin between Honshu and Hokkaido (profiles 27, 28 and 29).

In the southernmost area (profiles 1, 2 and 3), the feature on the continental slope is different from the other areas. There is no trench slope break developed and the continental slope has a rugged surface with a weak acoustic penetration.

Continental Shelf and Continental Slope along the Kulile Trench

In the western area (profiles 31–34), these features resemble those of the continental shelf and slope along the Japan Trench. The nature of the continental slope noticeably changes off Kushiro, in the eastern area from profile 35. A rather steep continental slope is developed in the eastern area, and no appreciable sedimentary deposits are observed with the exception of profile 38 which shows the presence of a sedimentary apron with a thickness of more than 1.6 seconds on the foot of the continental slope. Two prominent topographic peaks are observed on the slope. One is 3,000 m deep and extends through profile 34 to 40. The other is 2,000 m deep as recognized in profiles 40–43. These ridges consist of acoustic basement.

The continental shelf in the eastern area is composed of acoustic basement, although, in the easternmost profile (profile 45) off Etorofu Island, some layers of sediments are observed on the continental shelf.

Inner Trench Slope

There is a difference in acoustic pattern between the lower part and the upper part of the inner trench slope. Generally the upper part of the inner trench slope is relatively reflective and the lower part is weakly reflective as shown in profiles 20–23. A small bench is developed at the boundary between the upper trench slope and the lower trench slope. Several small ridges of weak reflectivity are observed on the foot of the lower slope (profiles 8, 19, 23, 24 and 34).

Trench Bottom, Outer Trench Slope and Oceanic Floor

Acoustically transparent sediments, 0.2–0.8 second thick, overlie the acoustic basement on the outer trench slope and the oceanic floor. There is no prominent reflector in the sedimentary layer as described by EWING and others (1968) in the Northwestern Pacific. The surface of acoustic basement shows a strong reverberent reflection or appears as a nearly smooth prominent reflector. The transparent layer is slightly reflective in parts and the thickness of the layer is nearly constant if there is no basement high such as seamounts and knolls.

Profile 35 shows the thinning of the transparent layer around a seamount. Profile 43 illustrates the abrupt change of the thickness of the transparent layer with a conspicuous displacement of acoustic basement. This displacement well corresponds to the fracture zone inferred by LARSON and Chase (1972) on the basis of the magnetic anomaly liniations.

Many conspicuous faults are recognized on the outer trench slope. They consist of a succession of grabens, horsts, normal step faults and thrusts. A profile showing these features is shown in Fig. VI-3. The near vertical displacements of both the sedimentary layer and the acoustic basement are very prominent on the profiler records. Individual faults can be traced for a maximum distance of 15 nautical miles and are nearly parallel or slightly oblique to the trench axis (profile 17–20 off Miyako). The downthrow of the faults which makes the grabens and horsts features becomes greater with increasing depth of the sea floor. Thurust faults are occasionaly observed on the outer trench slope adjacent to the trench bottom in the Japan Trench. They are widely recognized on the outer trench slope of the Kulile Trench.

Deformation on the outer trench slope are typically observed in other trenches, such as Peru-Chile Trench (PRICE and KULUM, 1975), Bonin Trench (TAMAKI, in print), Ryukyu Trench (TAMAKI *et al.*, 1976). However, the deformation features in the Japan Trench are one of the most prominent features.

The transparent layer along the outer trench slope extends to the trench bottom with nearly constant thickness or slightly thins towords the trench bottom. In contrast, the acoustic basement layer is traced downwards below the inner trench slope well beyond the trench bottom as shown in some profiles.

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