# III. 3.5 kHz SUBBOTTOM PROFILING SURVEY IN CRUISES GH79-2, 3 AND 4

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## 1. Introduction

A subbottom profiling survey was carried out with a 3.5 kHz PDR (subbottom profiler) along all the survey tracks of cruises GH79-2, 3 and 4 in order to clarify the surficial structure and distribution of sediments. The survey system comprises nine transducers (TR 75A), a tranceiver (PTR 105A), a correlation processor (CESP II), and a graphic recorder (UGR 196C), which were manufactured by Raytheon Co..

There may be a distinct echo and an indistinct echo in short 3.5 kHz pulses (DAMUTH, 1975). In many cases, we cannot get any subbottom information with 3.5 kHz pulses, but can get detailed information of the bottom topography from which we can estimate the surficial structure. Bottom and subbottom reflection patterns observed on 3.5 kHz records from cruises GH79-2, 3 and 4 can be

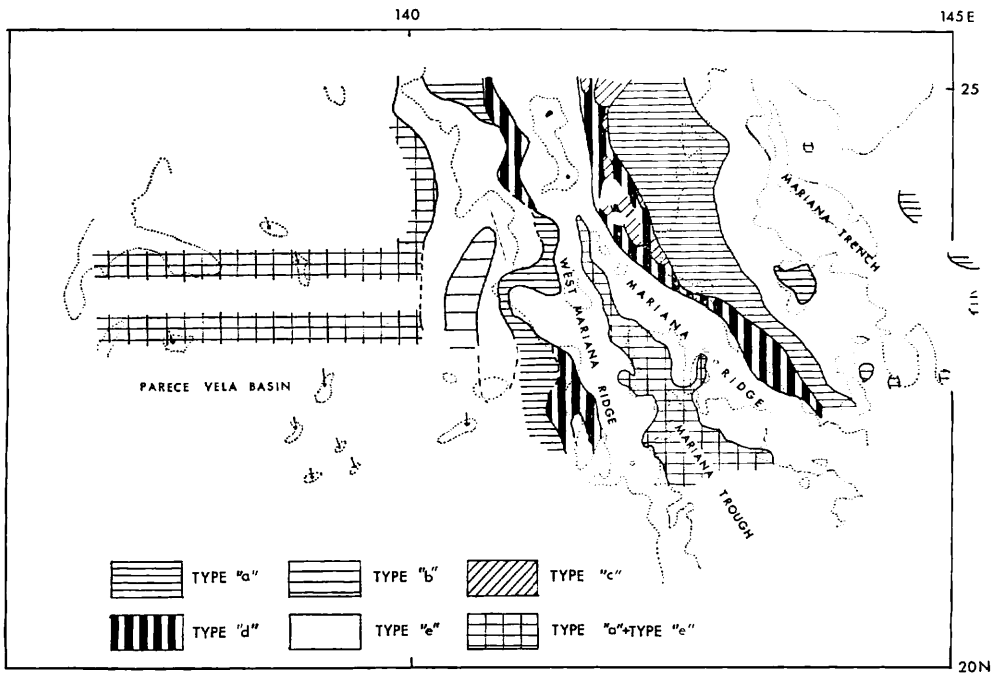


Fig. III-1 Distribution map of echo types by 3.5 kHz subbottom profiler in GH79-2 area.

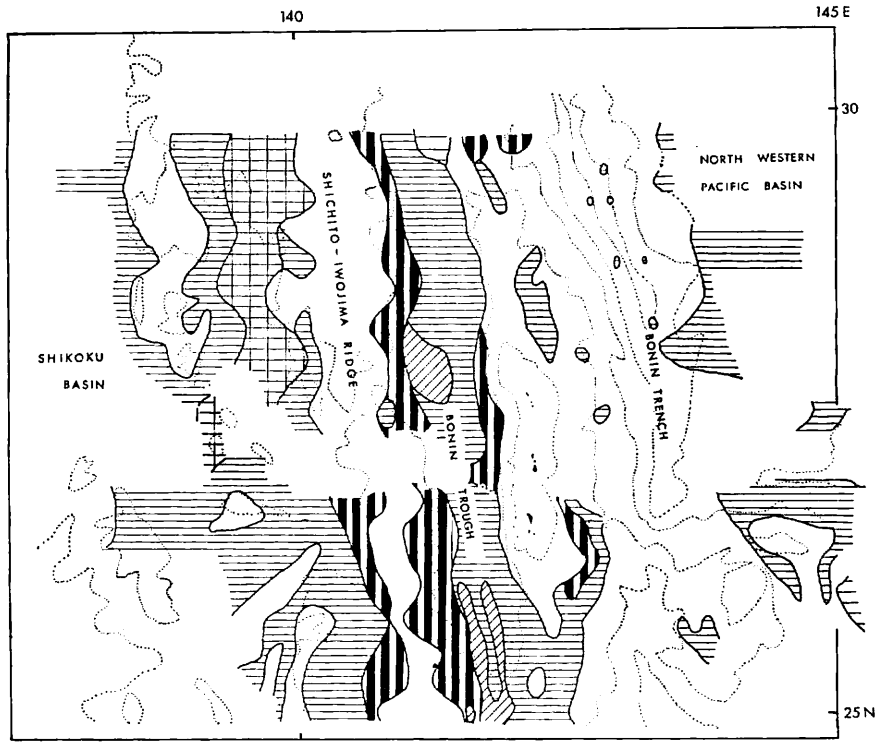


Fig. III-2 Distribution map of echo types by 3.5 kHz subbottom profiler in GH79-3 area.

divided into five types, "a", "b", "c", "d" and "e", based on the classification by DAMUTH (1975) (Figs. III-1, 2 and 3). Type "a" shows continuous, sharp bottom and subbottom reflections. It is observed in an area of flat sea bottom where extremely stratified layers are observed on the continuous seismic profiles. Type "b" shows a very prolonged, fuzzy bottom echo with no apparent subbottom reflectors. Type "b" is mainly observed in a steep slope area, in the summit area of a guyot or a volcanic ridge, on which well stratified layers or semi-opaque, incoherent reflections are observed on the seismic profiles. Type "c" consists of regular, overlapping hyperbolae with varying vertex elevations above the sea floor on a flat sea floor. Highly disturbed chaotic reflections are observed in a type "c" area by seismic profiling. Type "d" shows regular, overlapping hyperbolae with relatively uniform vertex elevations above the sea floor on a gentle slope area. Seismic profiles show a chaotic character resembling those in type "c" areas but relatively weak in type "d" areas. Type "e" is characterized by large, irregular, overlapping hyperbolae to broad, irregular, single hyperbolae with widely varying vertex elevations above the sea floor and is common in topographically rough regions. These areas correspond to the outcrop areas of acoustic basement observed on seismic profiles.

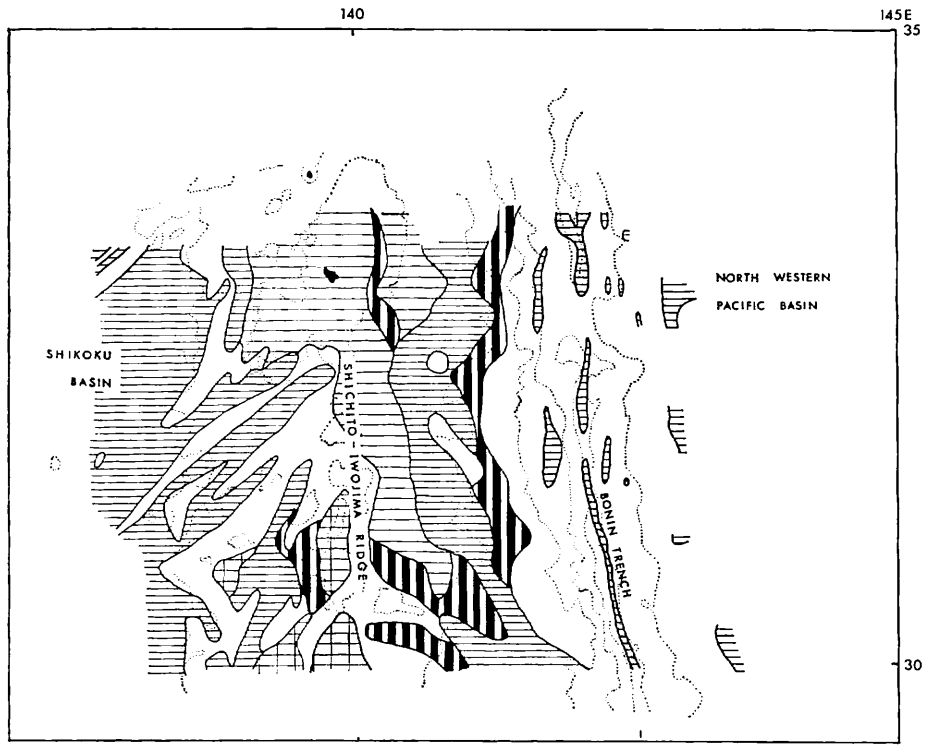


Fig. III-3 Distribution map of echo types by 3.5 kHz subbottom profiler in GH79-4 area.

## 2. Description of Results

*a) The Bonin Trough and Mariana Forearc Basin*

Type "a" is observed in the Mariana forearc basin and the Bonin forearc basin, including the Bonin Trough. The penetration of an acoustic wave of type "a" is generally weaker in these areas than in the Shikoku-Parece Vela Basin. A type "c" echo pattern is observed along the western end of the Bonin Trough and Mariana forearc basin (Fig. III-4, L24). On the Bonin Trough, the bottom depth of the main portion of the type "c" area is approximately 50 m shallower than that of the adjacent areas where different echo types are dominant. The marginal part of this area is overlain by type "a" sediments. Wide distributions of type "c" are observed northwest of Yomejima Island and northeast to east of Kita-iwojima Island. Here, based on the sampling results of the present cruises, type "a" has been approximated to the clay and/or silt which sometimes occur between tuff layers. Although the sediments showing a type "c" echo pattern have not been sampled during present cruises, the coring results of JACOBI and MROZOWSKI (1979) suggest a contorted mixture of clay, silt and volcanogenic sand.

Type "d" is commonly observed on the gentle slope along the eastern foot of the chain of volcanic islands (Shichito Ridge and Mariana Ridge). Sediment showing echo type "d" has been described as channel levee sediments and/or contourites

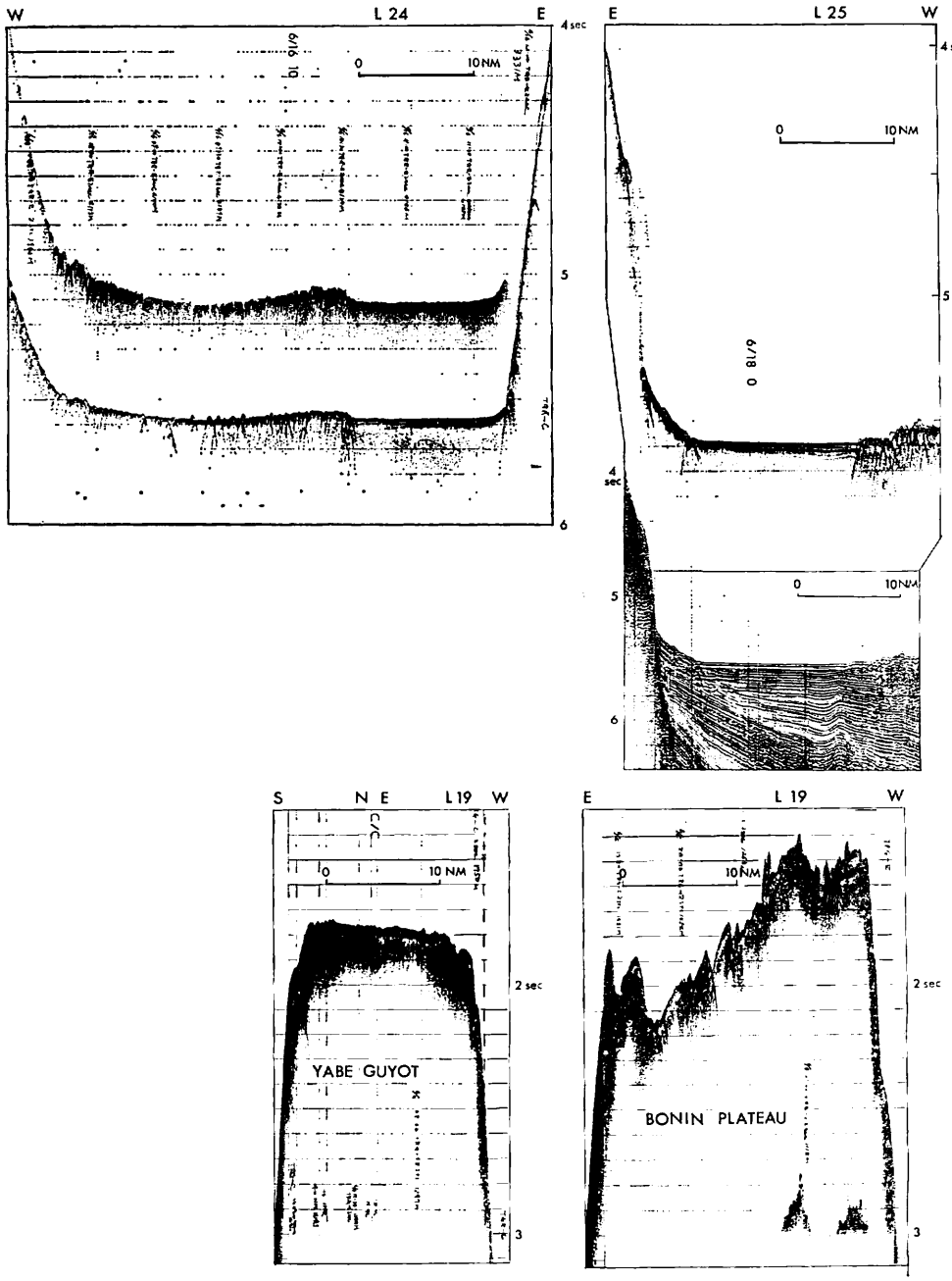


Fig. III-4 3.5 kHz echogram in the Bonin Trough along L24, L25 and L19. L24 : type "c" and type "a" patterns are observed on the western and eastern halves of the flat part respectively. Type "d" pattern is observed on the marginal area of the basin. L25 : 3.5 kHz echogram and seismic profile of the eastern half of the Bonin Trough along L25. The part showing type "d" pattern on 3.5 kHz echogram along the eastern margin of the trough is an outcrop of older slumped sediments, as shown on the seismic profile. L19 : highest part of the Bonin Plateau and the summit of the Yabe Guyot along L19. The distance between them is about 100 km. Note on the difference in smoothness of the topography between them.

(DAMUTH, 1975; JACOBI and MROZOWSKI, 1979). According to JACOBI and MROZOWSKI (1979), type "d" on the lower slopes of the ridges in this area shows a sediment wave structure thought to be formed by contour currents. However, seismic reflection records shows that type "d" along the eastern foot of the volcanic chain corresponds to a contorted layer which is covered by a stratified layer, and the type "d" area on the western foot of the Bonin Ridge appears to correspond to the outcrop of a semi-transparent, contorted layer which is intercalated by stratified layers (Fig. III-4, L25).

Several submarine channels are observed in the forearc basin of the northern Bonin Trough. A profile of the biggest channel has a depth of about 350 m and a width of 5 km. Small depressions between highs seem to be partly filled by sediments on the lower side. Sediment wave structures on the upper side of this section indicate the overflow of streams of sediment from the channel.

*b) The Bonin Plateau Area*

Type "e" is dominant on the Bonin Plateau and shows a very rough topography. Type "a" is intermittently observed in the narrow depressions of the plateau. In contrast, the Yabe Guyot which lies to the east of the Bonin Plateau, with its summit at almost the same depth as the Bonin Plateau, has a very flat surface with a type "b" pattern (Fig. III-4, L19). If the flat summit of the Yabe Guyot is the remnant eroded surface after the regional sea level change, the difference of topographic features and 3.5 kHz echogram reflection patterns between the Bonin Plateau and the Yabe Guyot may reflect the difference in their tectonic setting and history.

*c) The Bonin-Mariana Trench and Northwestern Pacific Basin*

The trench area mainly consists of type "e" with overlapping hyperbolae. Flat sediment fill of type "a" is obserbed in places on the landward trench slope. Type "a" echo pattern is not observed in the central to southern part of the Bonin Trench, but, in the northern part of the trench, small amounts of type "a" sediment fills the trench bottom (Fig. III-5, L47, L13). Flat layers of type "a" with relatively deep penetration are observed in the northwestern Pacific basin (Fig. III-5, L28).

*d) The Mariana Trough*

Both types "a" and "e" are observed in the Mariana Trough in which type "a" shows relatively deep penetration (Fig. III-6, L3). Layered sediments of type "a" fill the small depressions among the type "e" basement highs. Distribution of these types cannot be mapped, because the depressions and basement highs have very short ranges on all the survey tracks.

*e)The Shikoku-Parece Vela Basin*

A combination of types "a" and "e", the same as in The Mariana Trough, are observed in the Parece Vela Basin and also, in part, at the eastern margin of the Shikoku Basin (Fig. III-7, L11). Type "a" pattern, which continues for several kilometers, is observed in the flat part of the Shikoku-Parece Vela Basin. Type "e" is observed on the Izu Ridge, which shows a northeasterly en-échelon arrangement, while type "a", which shows the deepest penetration in this area, is observed in the trough between the ridges (Fig. III-6, L39). Penetration of acoustic waves

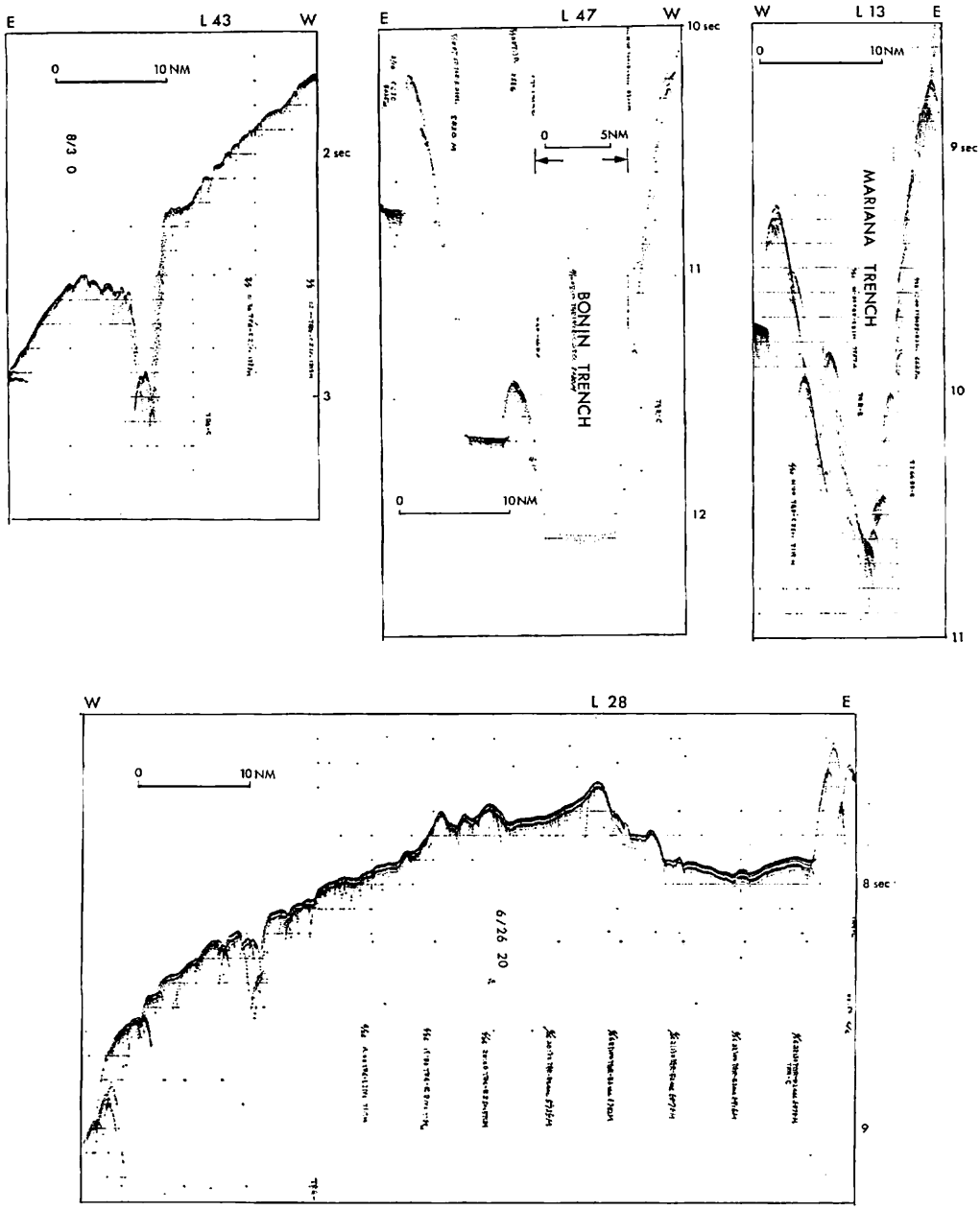


Fig. III-5 3.5 kHz echogram along the eastern foot of Shichito Ridge, along L43, L47, L13 and L28. L43 : it shows the submarine channel with sediment waves and partly filled small depressions on the upper and on the lower part of the bank. L47 and L13 : trench areas. Small accumulations of sediment showing type "a" pattern are observed along the bottom of Bonin Trench, along L47. On the other hand, sediments are lacking on the bottom of the Mariana Trench along L13. L28 : Northwestern Pacific Basin along the eastern end of L28. Type "a" with relatively deep penetration is widely distributed.

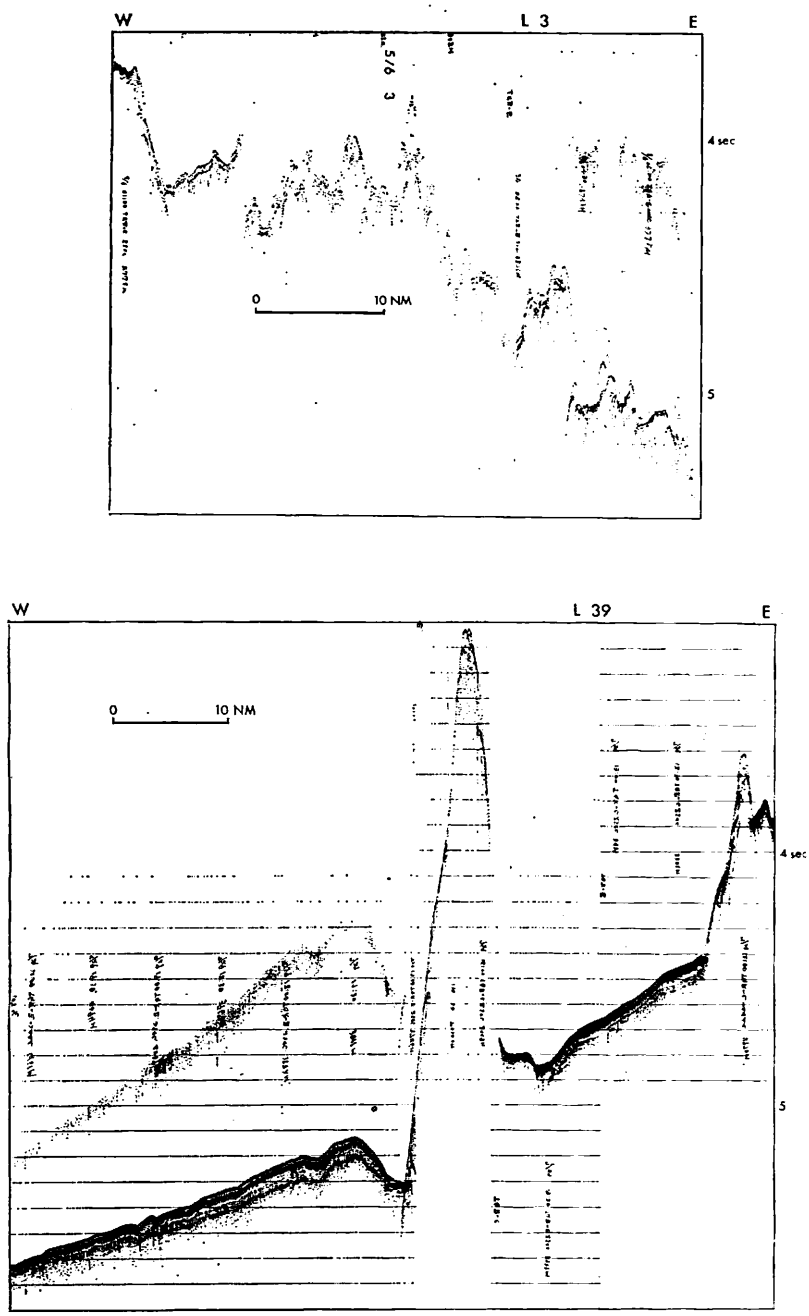


Fig. III-6 3.5 kHz echogram of the Mariana Trough along L3 and L39. L3 : type "e" pattern of basement depression can be observed. This type area is mapped as type "a" + "e" area in Fig. III-1, 2 and 3. L39 : eastern end of the Shikoku Basin. Sediment showing type "a" with deep penetration indicates the rapid sedimentation rate.

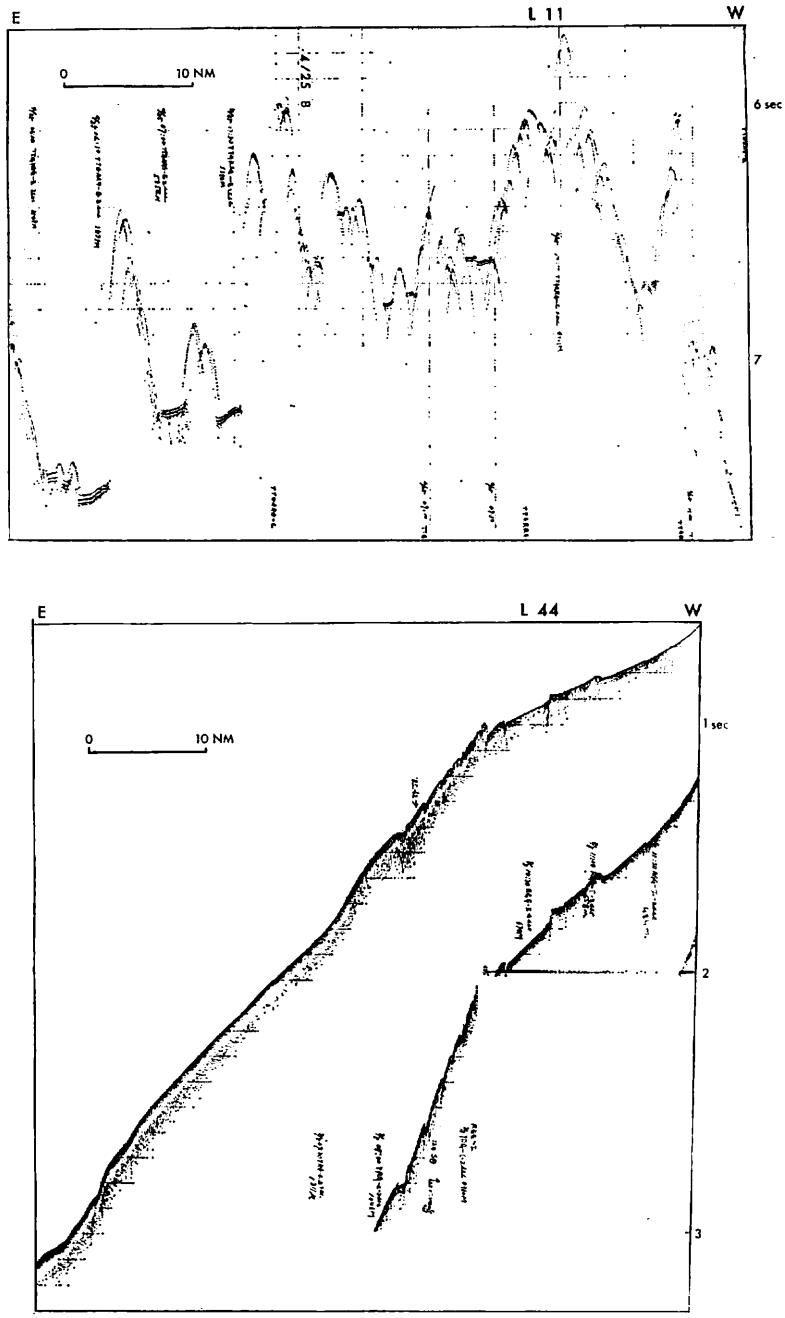


Fig. III-7 3.5 kHz echogram of the Parece Vela Basin along L11 and L44. L11 : it has the same pattern as the Mariana Trough, shown in Fig. III-10. L44 : eastern slope of the Shichito Ridge. Type "b" pattern with smooth bottom surface can be observed.

in type "a" sediments is generally deeper along the margin than in the central part of the Shikoku Basin. This feature may suggest rapid sedimentation in the marginal part as compared with the central part.

*f) The Ridges*

Most of the submarine ridges in the survey area show a type "e" pattern, which indicates topographic roughness. On the northern section of the Shichito Ridge, type "b" associated with a smooth bottom surface is widely observed (Fig. III-7, L44). Several recent volcanic islands are located in the type "b" area, and so type "b" can be correlated with volcanic material.

## 3. Summary

The acoustic pattern on a 3.5 kHz echogram is largely controlled by topography. Type "e" pattern is predominant on ridges and trench slopes which show very rough topography. Almost all of the Bonin Ridge, the Mariana Ridge, the West Mariana Ridge, and the southern part of the Shichito Ridge show a type "e" pattern on the echogram. The northern part of the Shichito Ridge shows only a type "b" pattern, probably because of the smooth surface of the sea bottom and lack of sediments. This smoothness of the bottom surface may be the result of flows of volcanic lava and ash from active volcanoes on the Shichito Ridge.

In the relatively flat basin area, patterns of type "a", "c" and "d" are predominant. In most of the Northwestern Pacific Basin, the Bonin Trough, and the Mariana forearc basin areas, a type "a" pattern is prevalent. Type "a" sediments fill the depressions between the basement highs in the Mariana Trough and the Shikoku-Parece Vela Basin where very rough basements are dominant. Type "c" and "d" characteristically show a regular, hyperbolic pattern and are regarded as sediment slide features. Sediments showing type "c" pattern are widely distributed along the western edge of the Mariana forearc basin and the Bonin Trough, and are estimated to have slid from west to east. Some older disturbed sediments which show type "d" pattern cropped out along the eastern edge of these basins, and dip to the west. The direction of the older sediment slide is thought to have been from east to west. These disturbed sediments alternate with sediments showing a type "a" pattern, and these features imply very active basin sedimentation and a probable change of sediment supply direction with time from westward to eastward.

## References Cited

DAMUTH, J. E. (1975) Echo character of the western equatorial Atlantic floor and its relationship to the dispersal and distribution of terrigenous sediments. *Mar. Geol.*, vol. 18, p. 17–45.

JACOBI, R. D. and MROZOWSKI, C. L. (1979) Sediment slides and sediment waves in the Bonin Trough, Western Pacific. *Mar. Geol.*, vol. 29, M1–M9.