III. 3.5 kHz ECHO SOUNDER PROFILING SURVEY IN THE AREA NORTHEAST OF HACHIJOJIMA ISLAND

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Purpose and methods

During a geological and geophysical survey of the area northeast of Hachijojima Island, the purpose of which is the compilation of a submarine geologic map of this area, a 3.5 kHz sub-bottom profiling survey was carried out along all the tracks. The sub-bottom profiler comprises nine transducers (Type TR75A), a tranceiver (Model PTR105A), a correlation echo sounder (CESP-II), a precision depth digitizer (Model PDD200A) and a universal graphic recorder (UGR 196C) all of which are manufactured by Raytheon Co., Ltd. We tried to correlate reflection characteristics with the sea bottom materials procured by sampling.

Results

Bottom and sub-bottom echoes recorded with 3.5 kHz sound pulse were classified into three types: Type-I, a sharp or prolonged bottom echo with no sub-bottom reflectors (Fig. III-2), Type-II, a semiprolonged or prolonged bottom echo with sub-bottom reflectors (Fig. III-3) and, Type-III, hyperbolic echoes (Fig. III-4). The distribution of each echo type is shown in Figure III-1.

Type I

This echo type is distributed over the whole area at water depths of less than 1000 to 1400 m. Two subtypes can be distinguished: Type-Ia, a sharp bottom echo and Type-Ib, a semiprolonged or prolonged bottom echo. Type-Ia echo occurred in the following four areas.

1. The Shinkurose and Kitakurose Banks which have a rocky bottom or are covered by gravel or coarse sand.
2. East of Hachijojima Island where rock or gravel is found.
3. North of Mikurajima Island where no sample was obtained.
4. North of the Kitakurose Bank which is covered by coarse or medium sand.

The Type-Ia echo occurred frequently between the 1000 to 1400 m bathymetric contours in the eastern part of the surveyed area where it graded into the Type-II echo. The Type-Ib echo occurred in the same region as Type-Ia except the four areas described above, where rock, gravel or sand were found. The distribution of rock, gravel and sand cannot be clearly distinguished by reflection characteristics.

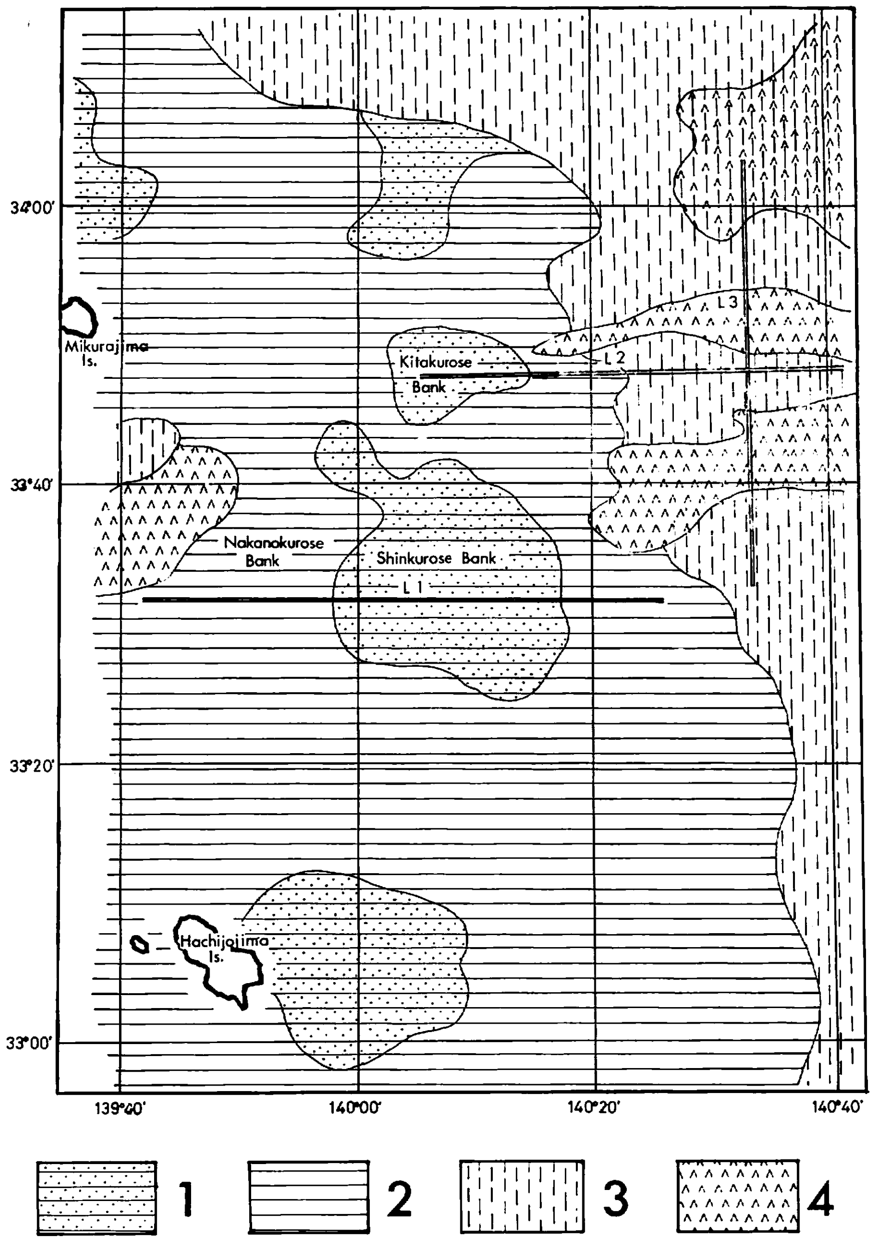

Fig. III-1 Distribution of echo types. 1: Type Ia, sharp bottom echo with no sub-bottom reflectors, 2: Type Ib, prolonged bottom echo with no sub-bottom reflector, 3: Type II, semiprolonged or prolonged bottom echo with sub-bottom reflectors, and 4: Type III, hyperbolic echo.

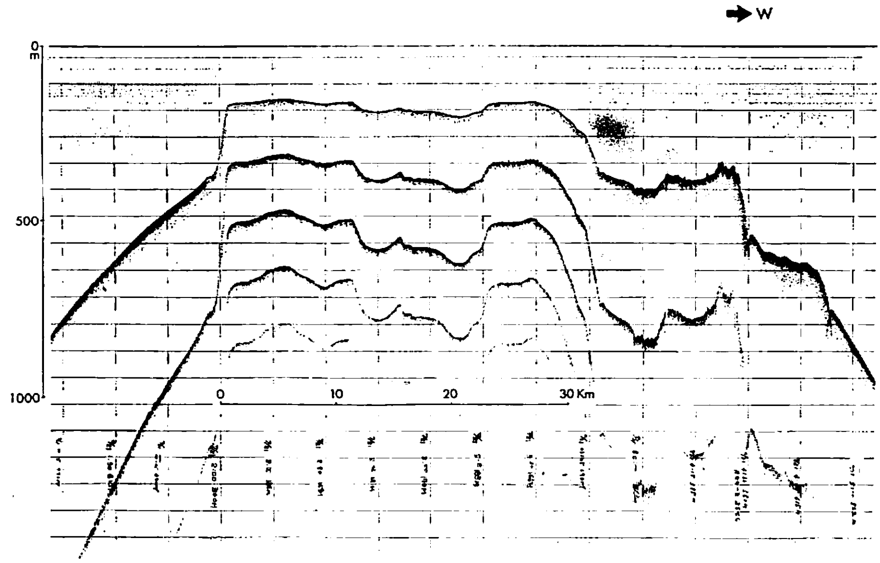

Fig. III-2 Type I shown in a profile of L 1 represented in Fig. III-1 by 3.5 kHz echo sounder.

Type II

This echo type occurred on the slopes at water depths greater than 1000 to 1400 m and corresponded closely with the distribution of muddy sand and mud. The depth of penetration of the sound waves and the number of sub-bottom reflectors increased with increasing depth of the surfaces of the slopes. At the bottom of the submarine canyons east of the Shinkurose and Kitakurose Banks, this type echo sometimes occurred (Figs. III-3 and 4).

Type III

Large, irregular, overlapping or single hyperbolae are characteristics of the submarine canyons east of the Kitakurose and Shinkurose Banks and on the slope west of the Nakanokurose Bank where the bottom morphology is rugged. In the northeastern part of the surveyed area, the Type II echo occurred among Type-III hyperbolae. Elevations of the vertices of the hyperbolae above the sea floor vary widely from 10 to 300 m.

Discussion

No sub-bottom reflectors appeared on the 3.5 kHz echo-sounder profile where there was a rocky bottom or in areas covered by gravel or sand, so the sedimentary structures of the surface sediments in these areas could not be determined, but their bottom-echo characteristics varied from sharp (Type Ia) to prolonged (Type Ib). The Type-Ia echo often occurred where there was a rocky bottom or an area covered by gravel. The rocky bottom, however, did not always show a

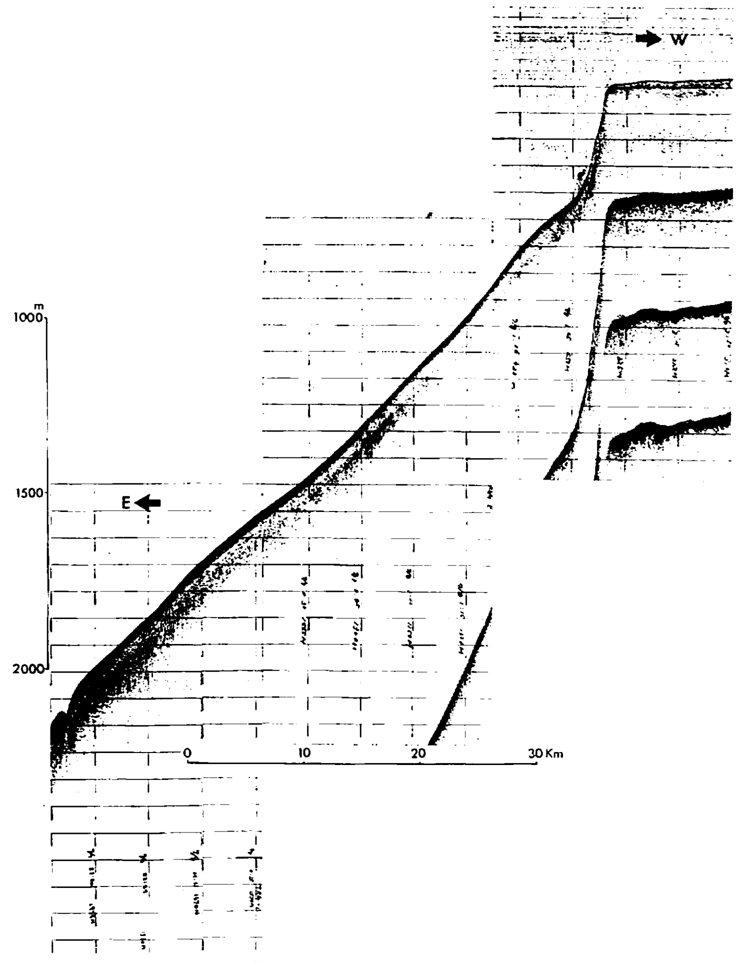

Fig. III-3 Type II shown in a profile of L 2 represented in Fig. III-1 by 3.5 kHz echo sounder.

Type-Ia echo; it showed a Type-Ib echo on the Nakanokurose Bank and to the southeast of the Shinkurose Bank. The bottom covered by gravel also showed a Type-Ib echo east of Hachijojima Island and to both the north and south of the Nakanokurose and Shinkurose Banks. On the slope north of the Kitakurose Bank, where coarse or medium sand is found, a Type-Ia echo occurred. The factors which control the bottom echo characteristics are not only the grain size of bottom sediments, but many other factors such as the porosity and thickness of the sediments, smoothness of bottom surface etcetra, and all these must be taken into account. The correlation between sea-bottom sediments and bottom-echo characteristics is difficult with only our present knowledge and further study will be necessary.

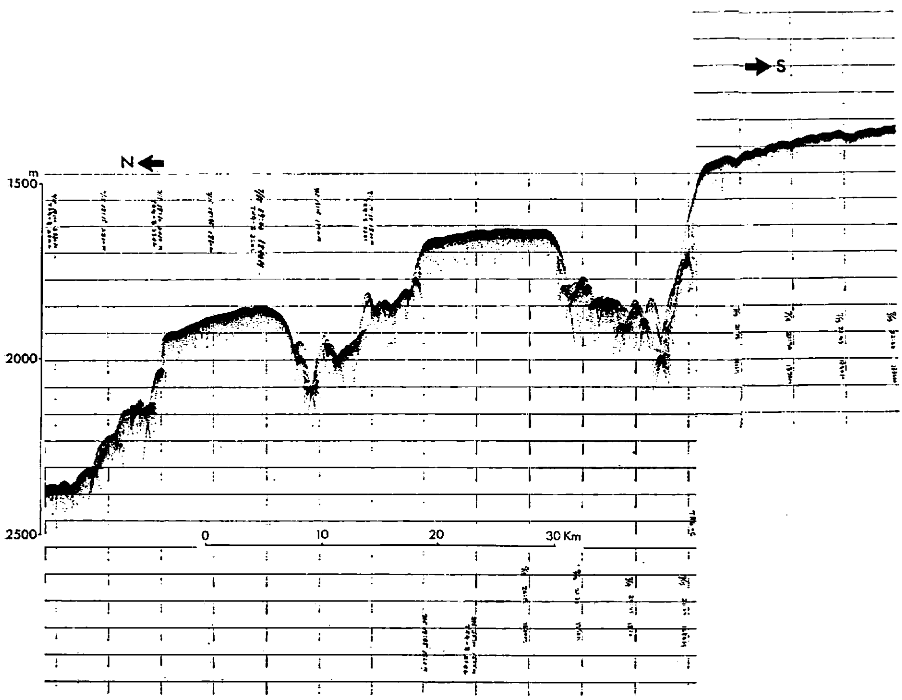

Fig. III-4 Type III shown in a profile of L 3 represented in Fig. III-1 by 3.5 kHz echo sounder.

The distribution of muddy sand and mud is closely related to the occurrence of the Type-II echo. The appearance of sub-bottom reflectors indicates that these sediments consist of layers having different acoustic properties. An increase in the depth of penetration of the sound waves and in the number of sub-bottom reflectors in the Type-II echo with increasing water depth might be caused by the thickening of fine-grained sediments. This echo type occurred throughout the whole area including the submarine canyons, at the water depths greater than 1400 m, and this suggests that the fine-grained sediments were deposited throughout these areas after the present submarine topography had formed.

East of the Kitakurose and Shinkurose Banks two canyons develop abruptly on the slope at a water depth of about 700 m, although there is no indication of them on the slope at depths of less than 600 m. Large, irregular and overlapped hyperbolae occur on the walls of the canyons, which indicate that these canyons have several branches. The vertical relief of the canyon wall varies from 230 m to 650 m and the width varies from 400 to 1400 m. The southern wall of the canyon is higher than the northern one, which indicates that the northern wall has sunk in relation to the southern one. These data suggest that the canyons have developed along the E-W trending, normal faults which are estimated to have a vertical displacement of about 50 m.