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III. SUBSURFACE ACOUSTIC LAYERS DETECTED BY 3.5 kHz SUBBOTTOM PROFILER IN THE SOUTHERN PART OF THE CENTRAL PACIFIC BASIN (GH82-4 AREA)

Manabu Tanahashi

Introduction

A subbottom profiling survey was carried out by a 3.5 kHz subbottom profiler (SBP) along all the survey tracks of the GH82-4 area around the Nova-Canton Trough in order to clarify the structure of surficial sediments and relationships to manganese nodule distribution. The topography and tracks of the regional and detailed survey areas of the GH82-4 cruise are shown on Figures III-1 and III-2, respectively.

The SBP system consists of nine transducers (TR75A), a transceiver (PTR 105A), a correlation processor (CESP II), and a graphic recorder (LSR 1811) manufactured by Raytheon Co. Ltd. A 100-msec long acoustic pulse was transmitted every 6 seconds. The ship speed during the survey was about 10 knots. Then horizontal resolution (record spacing) is about 30 m. The reflected signal was recorded in 2-second range, and line density of the record was 80 lines/inch. The thickness of layer is recorded in meter assuming a velocity of 1500 m/sec in the sediments.

Acoustic characters

Acoustic characters and reflectors on SBP records nearly coincide with those of Unit I detected on the air-gun seismic profiles. The distribution of acoustic layers is shown in Figure IV-3 from Tanahashi (chapter IV, this volume).

The transparent layer is well developed in flat basins, small depressions, and as small patches in the gentle slopes of the hills and seamounts in the south of the Nova-Canton Trough (Fig. III-4). The lower boundary of the transparent layer is not clear when the layer is thicker than 0.15 sec. It sometimes intercalates parallel reflections interpreted as turbidites in the basin area. The thickness of the transparent layer generally decreases from basin to slope.

The filling sediments in the Nova-Canton Trough show fine to moderate stratifications (Fig. III-5). The downwarping deformation of the stratification and depression-fill structure show a progressive deepening of the trough during sedimentation.

Turbidite basin

There are several well-developed turbidite bearing sedimentary basins in the survey area. There is a thick turbidite basin in the north of the Nova-Canton Trough

Keywords: subbottom profiler, manganese nodule, turbidite, bottom current, transparent layer, Central Pacific Basin, Hakurei-Maru, Nova-Canton Trough

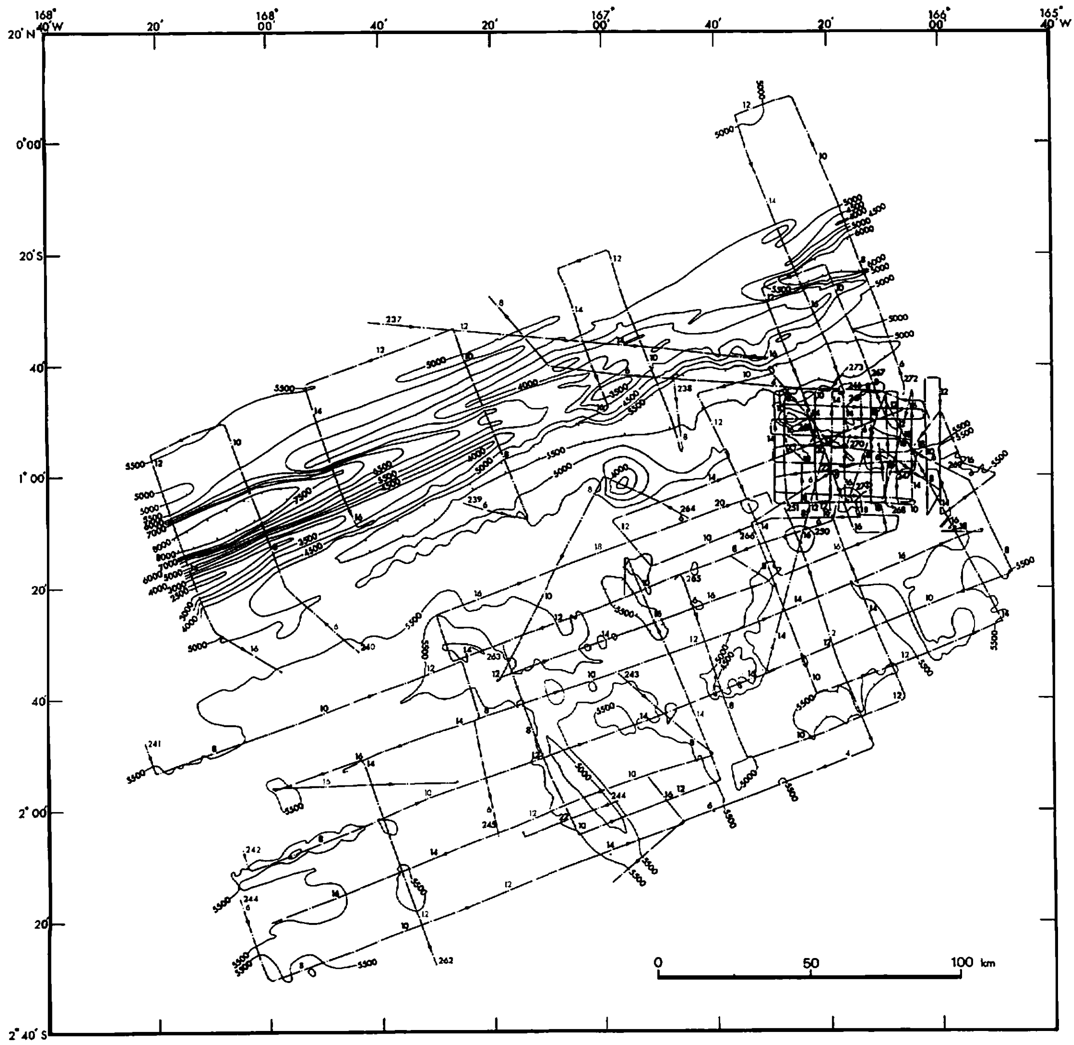

Fig. III-1 Survey track with SBP survey in the GH82-4 area.

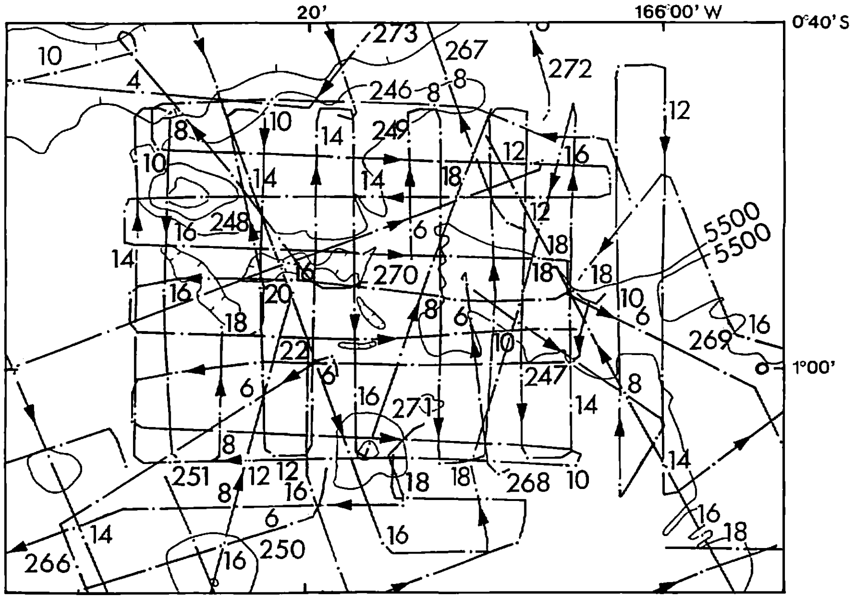

Fig. III-2 Survey track with SBP survey in the detailed survey area.

(Fig. III-6). The bottom of the turbidite basin can be detected only on seismic profiles, and the thickness of turbidite is about 0.5-0.6 sec. Many piercement structures are recognized in the turbidite basin and interpreted as volcanic intrusions (Tanahashi, chapter IV of this volume). The foot of the piercements has the moat-like depression interpreted as an erosional feature caused by bottom current. Subbottom profiles on Figure III-6 shows that the two piercements in right part drag fine stratified sequence to upward. The uppermost transparent part of the sediment column shows the erosional feature at the piercement. It indicates that the bottom current activity commenced after turbidite deposition or that the structure appeared over the sea-floor after turbidite deposition. There is another moat structure in left part of Figure III-6, which suggests erosion at deeper horizons than that along the margin of the turbidite basin. It is inferred that the piercement structure appeared over the sea-floor after the turbidite deposition about 10 Ma deduced from comparison of thicknesses of transparent layers in the turbidite basin and its vicinity.

There are two northwesterly-elongated turbidite basins in the south of Nova-Canton Trough (Fig. III-3). Turbidite appears mainly as intercalation in the western basin and as thick accumulation in the central basin. The migrating sediment wave structure, which suggests the turbidite supply from the southeast, is observed in the central basin (Fig. III-7).

Detailed survey area

A detailed survey area is located in the eastern part of the survey area, south of the Nova-Canton Trough. The thickness of transparent layer overlying opaque unit is

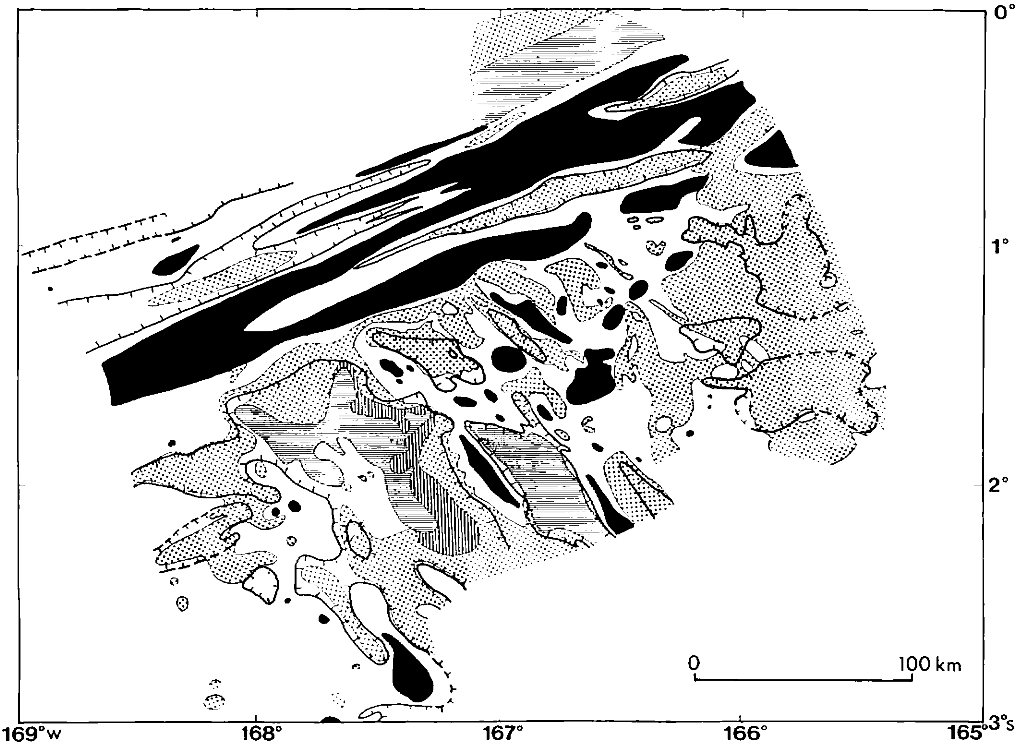

Fig. III-3 Distribution of seismic character (see Tanahashi, chapter IV of this volume). Dotted area is the transparent layer distributed area. Horizontally shaded area is turbidite distributed area. Vertically shaded area is the mixture of transparent layer and turbidite distributed area. Other areas are exposed basement or undetectable thin sediment.

mapped in Figure III-8 together with manganese nodule distribution (Usui, chapter X of this volume).

The area is structurally bounded by the ENE-trended Nova-Canton Trough to the north and the NW-trended North Plateau of the Manihiki Plateau to the south. The topography is generally rough. An east-west elongated hill with a peak (3900 m in water depth and 1500 m elevation) on the western end extends to the northwestern part of the area. A gentle depressions in the central part and NW elongated small ridges and troughs are another typical topography in the southwestern part. A flat-topped high elevation (800 m) from the basin is observed in the center of southern margin. A relatively large depression of 5500 m depth lies northwesterly in the southeastern end. A gentle slope from 5000 to 5500 m depth is developed on the northeast part.

The transparent layer is distributed in the southeastern depression, northeastern gentle slope, and central to southeastern small troughs. The maximum thickness of the layer is about 0.15 sec (110 m) along the axis of the southeastern depression. The thickness of the layer varies in places generally controlled by the topography. However, it varies considerably even in broad depressions or gentle slopes. A moat-

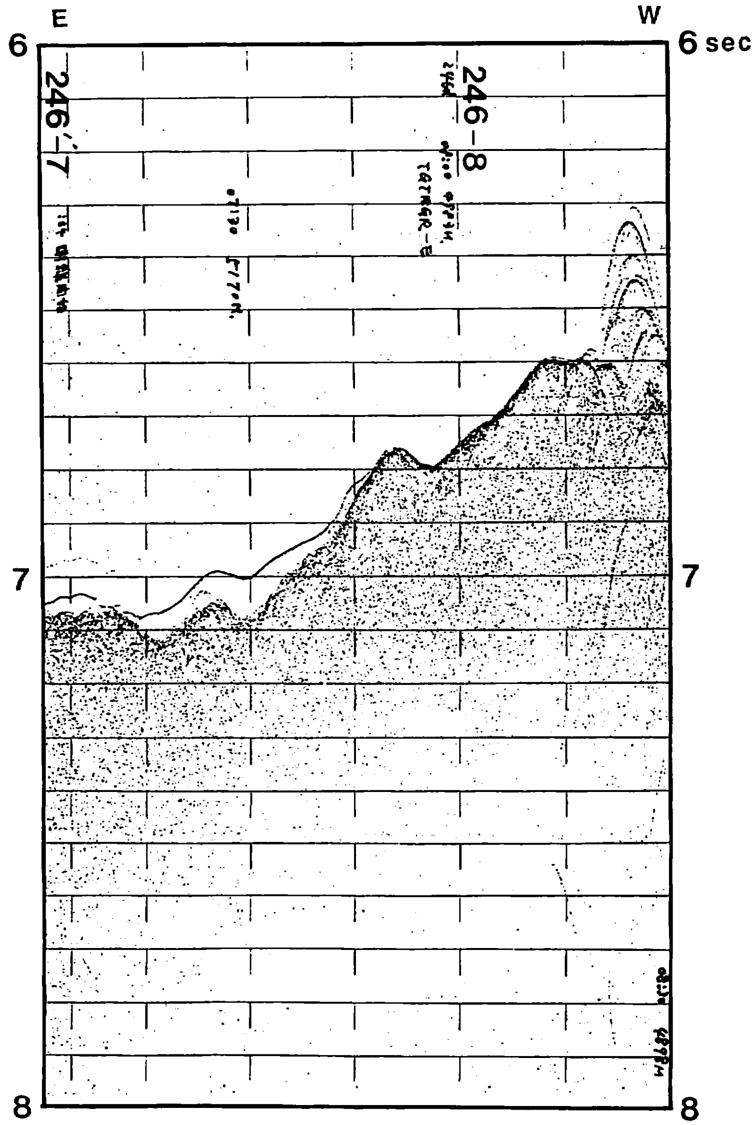

Fig. III-4 Example of SBP record of patchily distributed transparent layer on the gentle slope.

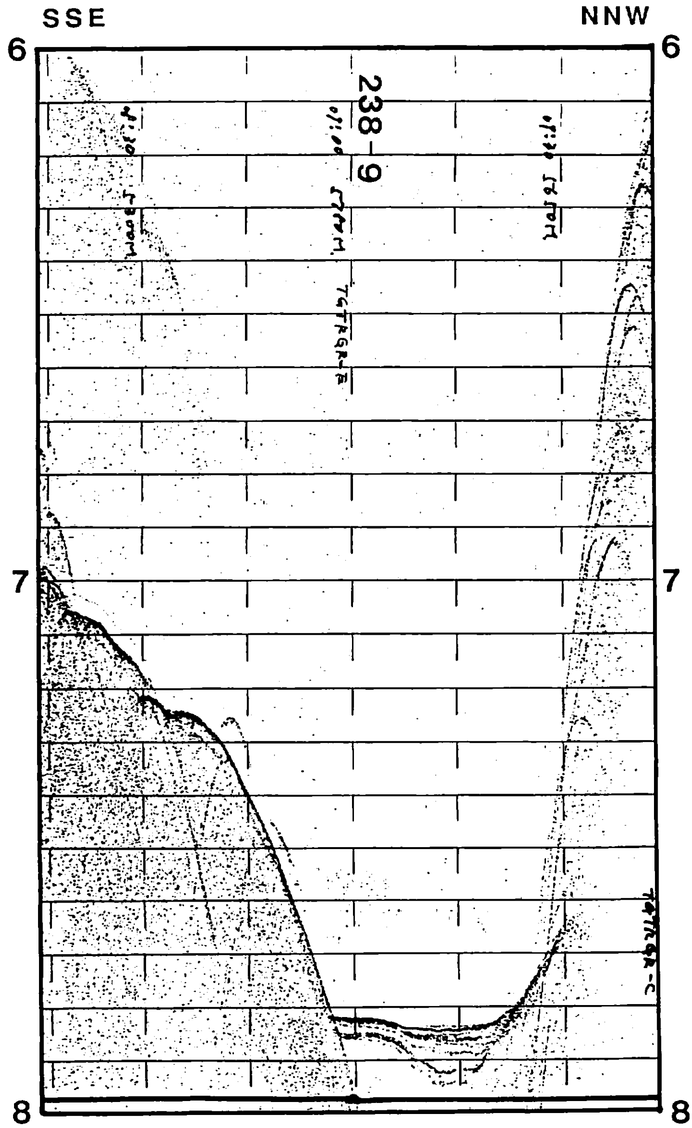

Fig. III-5 Downwarping structure and filled depression in the Nova-Canton Trough.
The structure suggests progressive deepening of the trough during sedimentation.

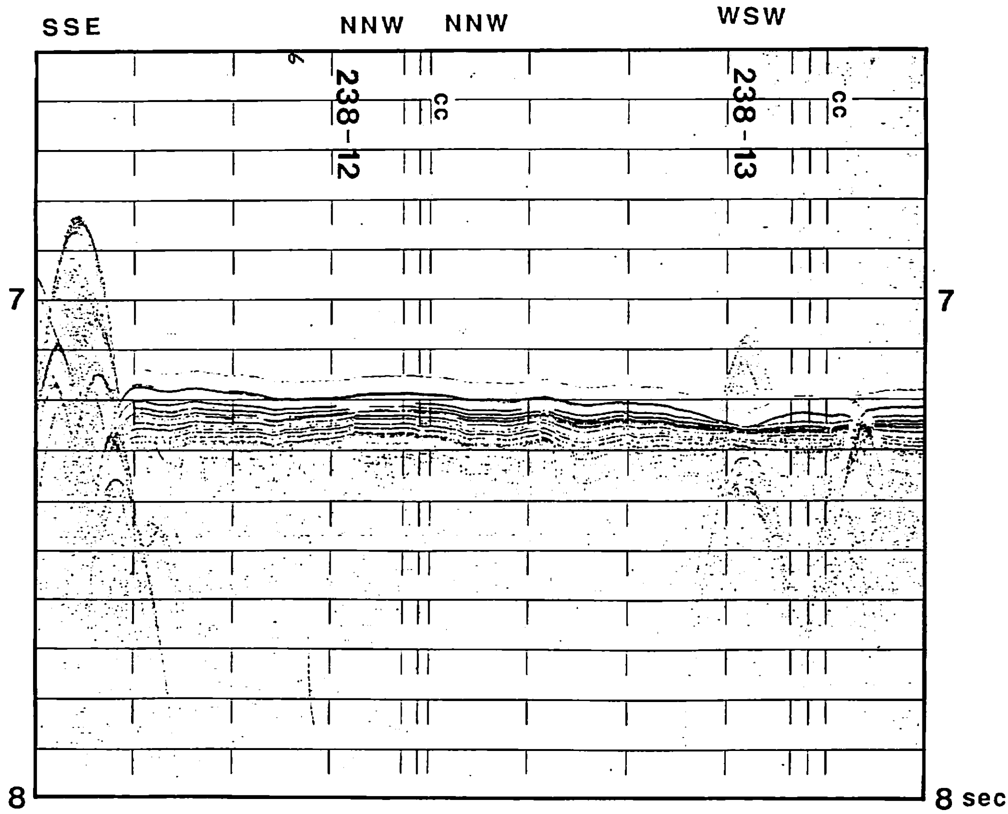

Fig. III-6 Example of turbidite layers and piercement structure in the basin north of the Nova-Canton Trough.

like depression of about 4 km width and 0.1 sec (about 75 m) relative depth, develops on the northeastern and western margin of the southeastern depression. Transparent layer is thin or lacked in the moat-like depression. The moat-like depression suggests that the bottom current activity has been enhanced along the barriers.

Almost no transparent layer can be observed in high lands shallower than 5100 m in water depth. The transparent layer is also lacked in the topographically rough areas, for example, the northern part of central depression. Another area of no transparent layer is found on the northeastern margin of the southeastern depression, where the slope is steeper than in the north.

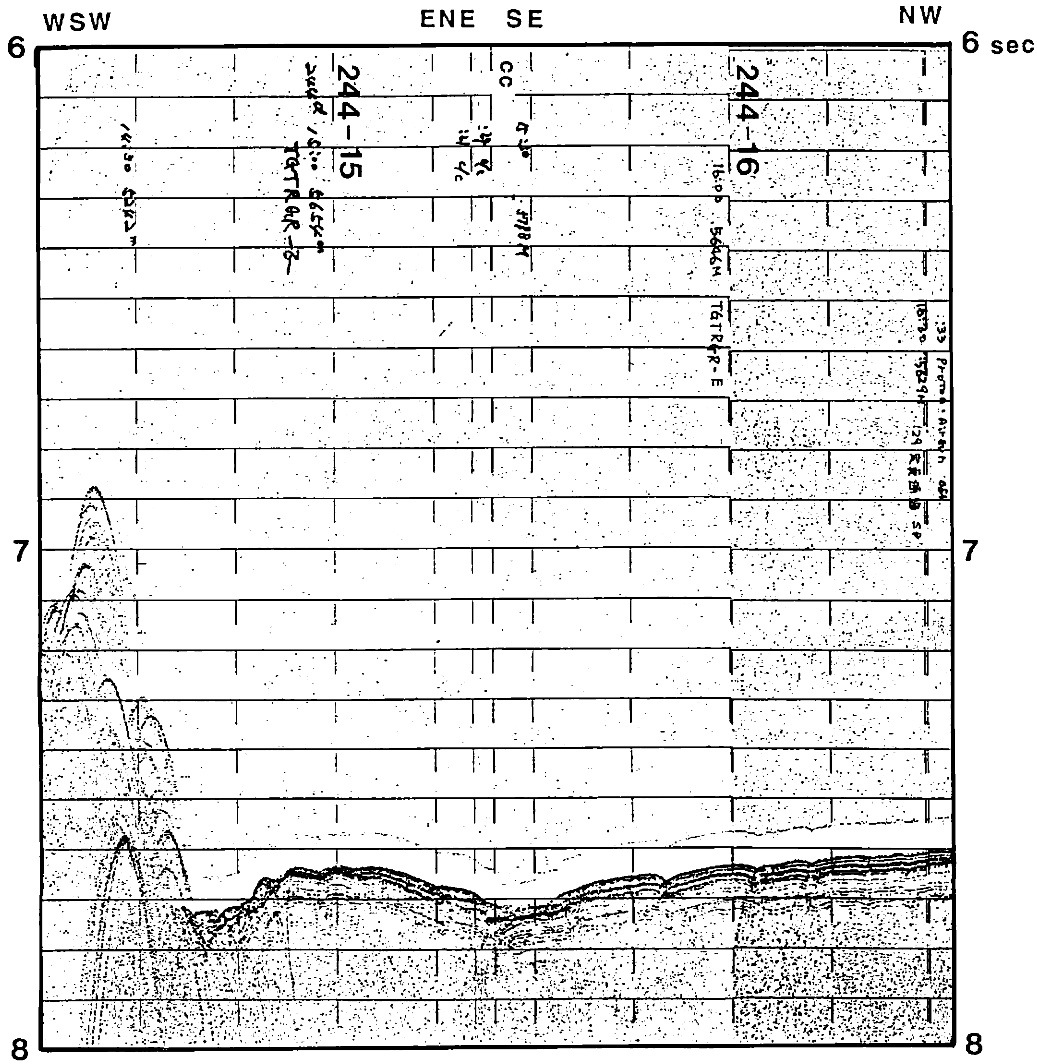

Fig. III-7 Wavy stratified structure of surficial turbidite layers in the southern northwesterly elongated turbidite basin.

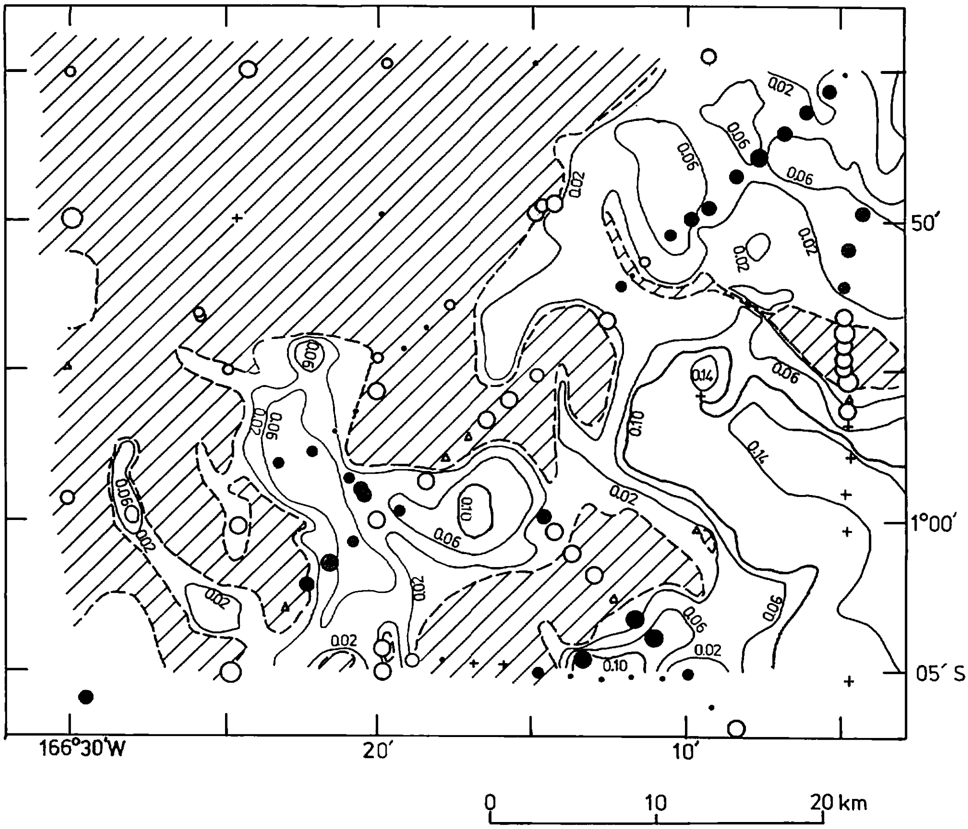

Fig. III-8 Thickness of transparent layer in the detailed survey area. Shaded area is exposed basement. Unit of thickness of the layer is shown in two-way travel time in seconds. Thickness of 0.1 sec corresponds about 75 m. Circles show the manganese nodule distribution (Usui, chapter X of this volume). Size of circles correspond nodule abundance, cross: no nodule, filled circle: type s, shaded circle: intermediate type, open circle: type r, triangle: manganese crust.

Manganese nodule distribution

Manganese nodule facies is closely related to development of the uppermost transparent layer (Usui and Tanahashi, 1986). The manganese nodule in the Central Pacific Basin is classified into type r, type s, and intermediate type according to surface structure which reflects the composition and origin. The relationship between the uppermost transparent layer distribution and the manganese nodule distribution in this survey area is shown on Figures III-8 and III-9 (also see in chapter XI of this volume). Type s is associated with very thin or no transparent layers on the slopes and deep-sea hills. By contrast, type r is related to moderate thickness of transparent layer up tp 80 m. The maximum abundances of nodule at given transparent layer thickness is nearly reversely correlated to the transparent layer thicknesses. No nodule is found in areas of thicker transparent layer than 80 m.

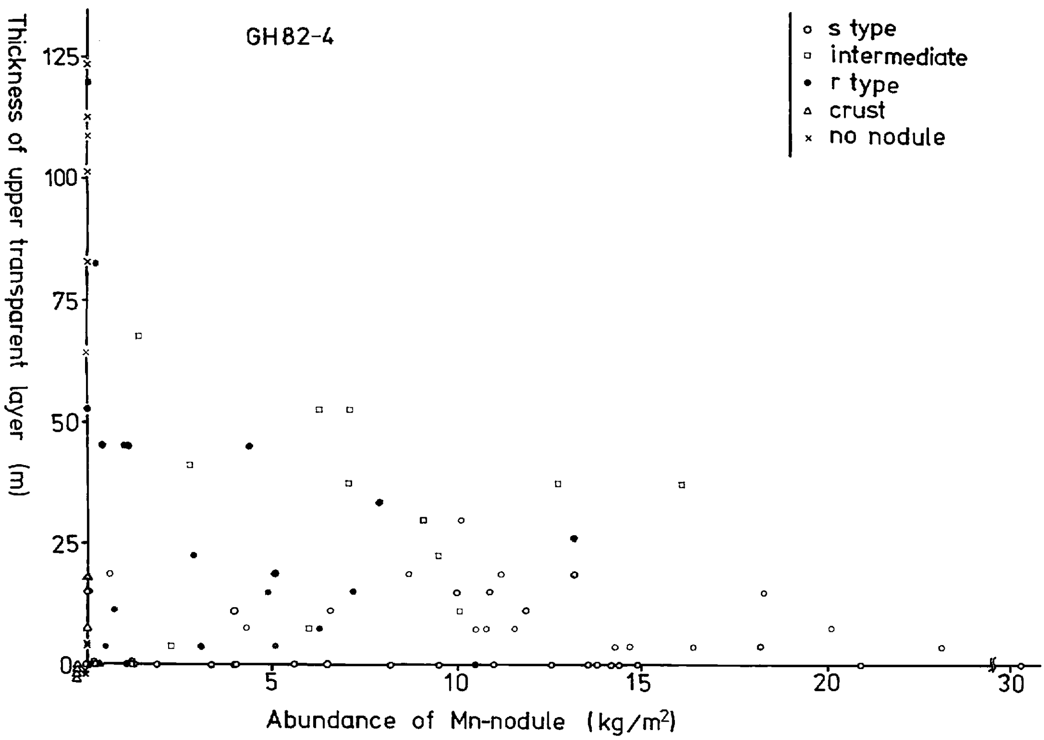

Fig. III-9 Relationship between thickness of transparent layer and abundance of manganese nodule in the detailed survey area.

References

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