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III. SUBSURFACE ACOUSTIC LAYERS DETECTED BY 3.5 kHz SUBBOTTOM PROFILER IN THE GH81-4 AREA (EASTERN PART OF THE CENTRAL PACIFIC BASIN)

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Introduction

A subbottom profiling survey was carried out by a 3.5 kHz subbottom profiler along all the survey tracks of the GH81-4 area in order to clarify the structure of surficial sediments and make a correlation between manganese nodule distribution and surficial sedimentary sequences. The topographic map and survey track lines of the GH81-4 cruise are shown on Fig. III-1.

The survey system consisted of nine transducers (TR75A), a tranceiver (PTR 105A), a correlation processor (CESP II), and a graphic recorder (LSR1811), which were manufactured by Raytheon Co. Ltd. Acoustic pulse was kept in 100 msec in length, and transmitted in every 3 seconds. Ship speed during the survey was about 6 knots. Then the horizontal resolution (record spacing) is about 9 m. The reflected waves were recorded in 1 second range, and line density of the record were kept 100 lines/inch. The thickness of layer is described in meter using an assumed velocity of 1,500 m/sec in the sediment.

General features

There are two knolls in the GH81-4 survey area. Northern knoll elongates about 20 km in NW-SE direction and maximum relative height from the surround basin is about 350 m. Southern knoll elongate over 10 km in N-S direction and maximum relative height is over 250 m. The water depth of flat basins around knolls is about 5,550 m. Typical profiles across the northern and the southern knolls are shown on Figs. III-2 and III-3, respectively.

The acoustic character detected by 3.5 kHz Subbottom Profiler is quite simple. There are upper transparent layer and lower acoustic basement. Transparent layer is correlated to Unit I, post Oligocene siliceous ooze or siliceous clay, which is detected on the seismic profiles with air gun and water gun. Acoustic basement cannot be detected in the places where the transparent layer is thick. The acoustic basement is usually correlated with Unit IIa on the seismic profiles in the basin area, or with the possible volcanic acoustic basement on the seismic profiles in the knoll area.

The thickness of the transparent layer is about 150 m in average and does not varies very much in the basin area. On the knoll, the layer is thinner than that in the basin area and changes its thickness very much. The thickness distribution of transparent layer, which is mapped based on the record of both 3.5 kHz SBP and seismic profiler, is shown on Fig. III-4. The transparent layer in the northeastern basin is generally thicker than that in the southwestern basin.

Sedimentary structures

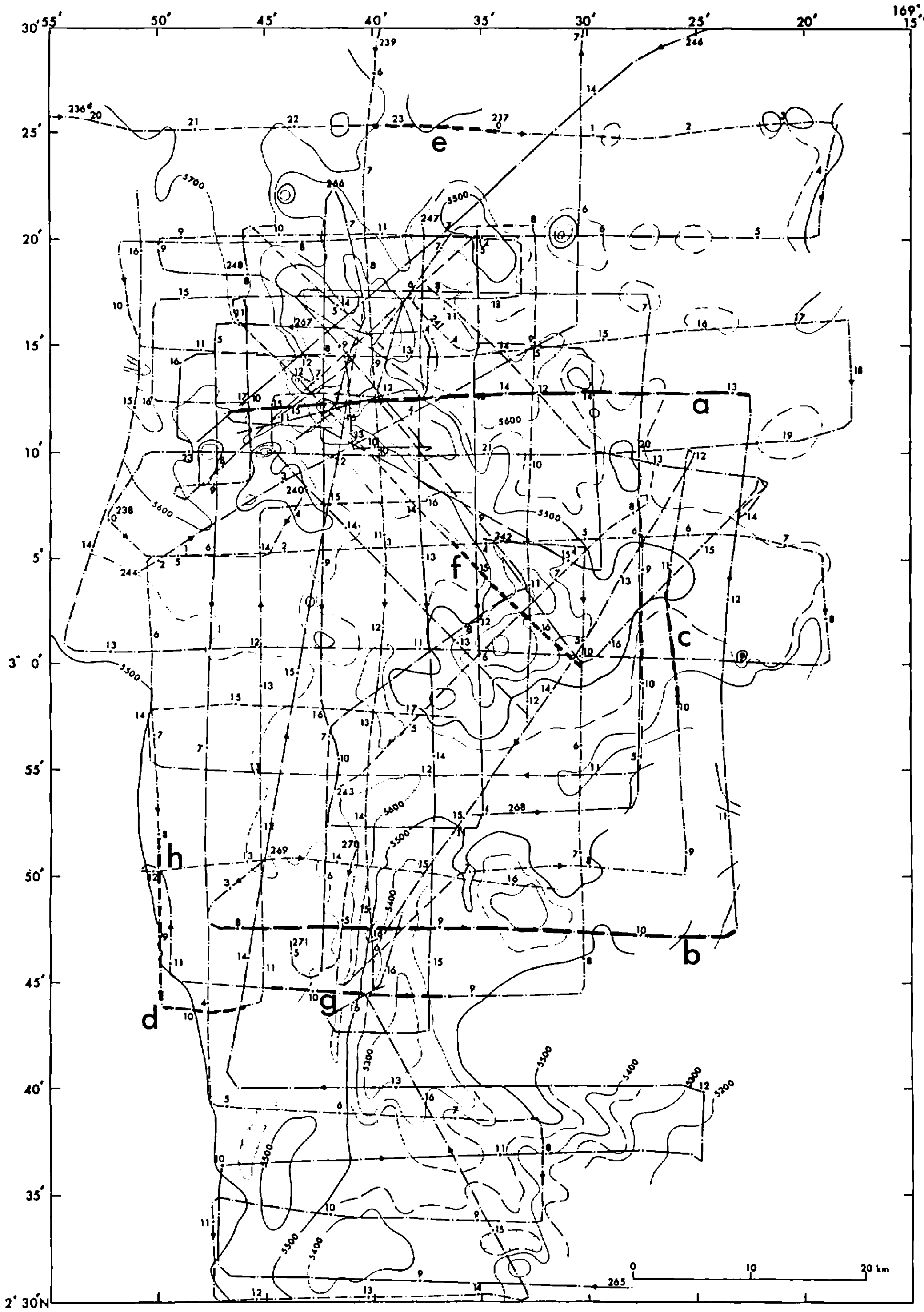

Fig. III-1 Topography and survey track lines in the GH81-4 survey area. Thick lines show the location of profiles in the text. Letters a, b, c, d, e, f, g and h show the location of profiles on Figs. III-2, 3, 6, 7, 8, 9, 10 and 11 respectively.

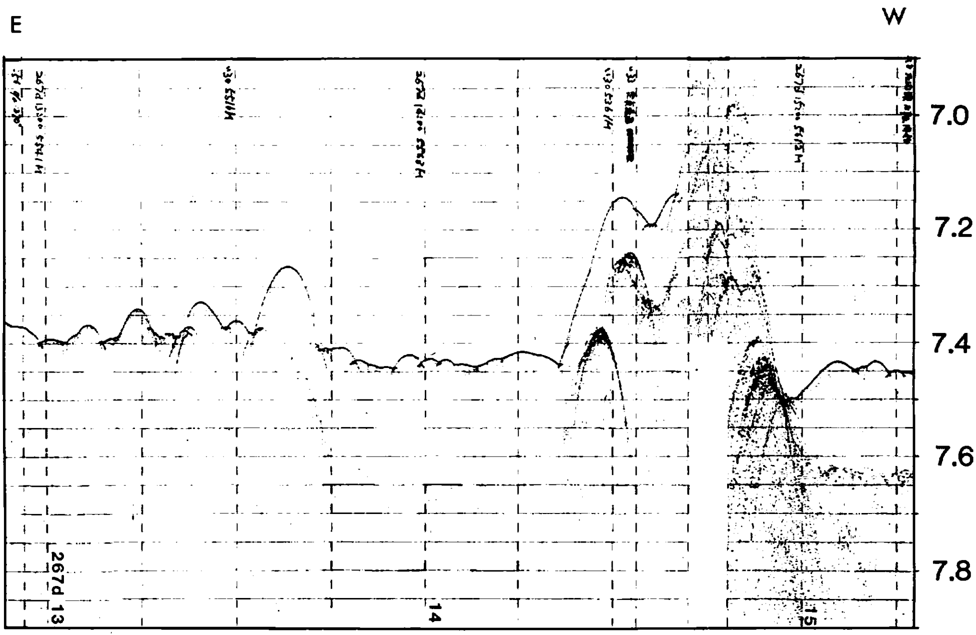

Fig. III-2 3.5 kHz profile across the northern knoll at 3° 12.5'N. The acoustic basement cannot be identified in the eastern basin area. Many small topographic highs and depressions are developed in the basin. Clear depression is developed in the western foot of the knoll.

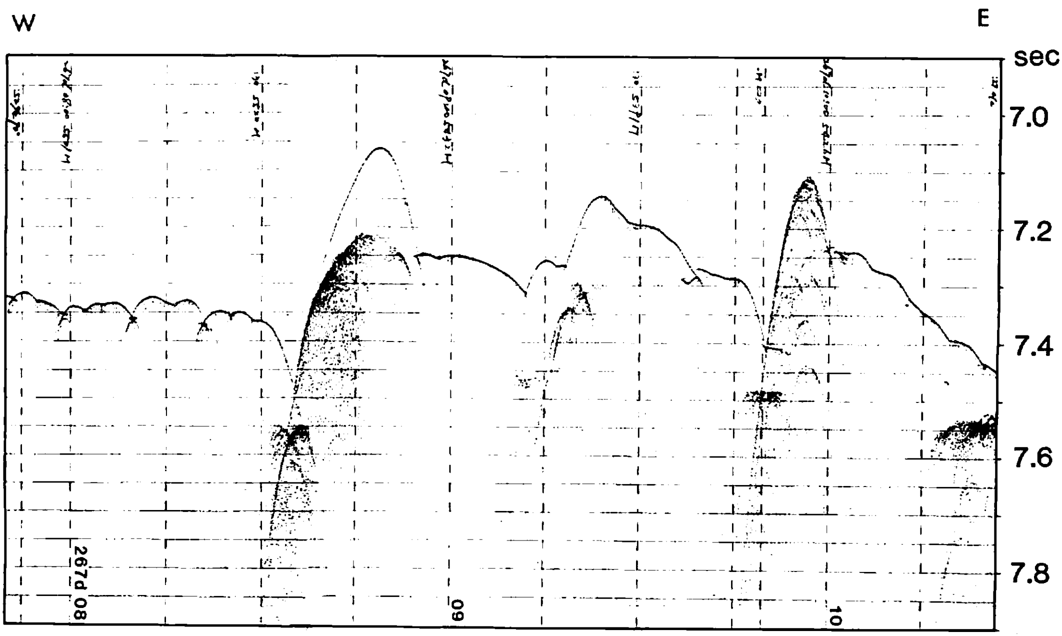

Fig. III-3 3.5 kHz profile across the southern knoll at 2° 47.5'N. Deep (150 m) depression in which no transparent layer can be observed is developed in the western foot of the knoll. Another moat-like depression can be seen on the western foot of the eastern knoll. Three small channels with flat bottom can be observed in the western basin.

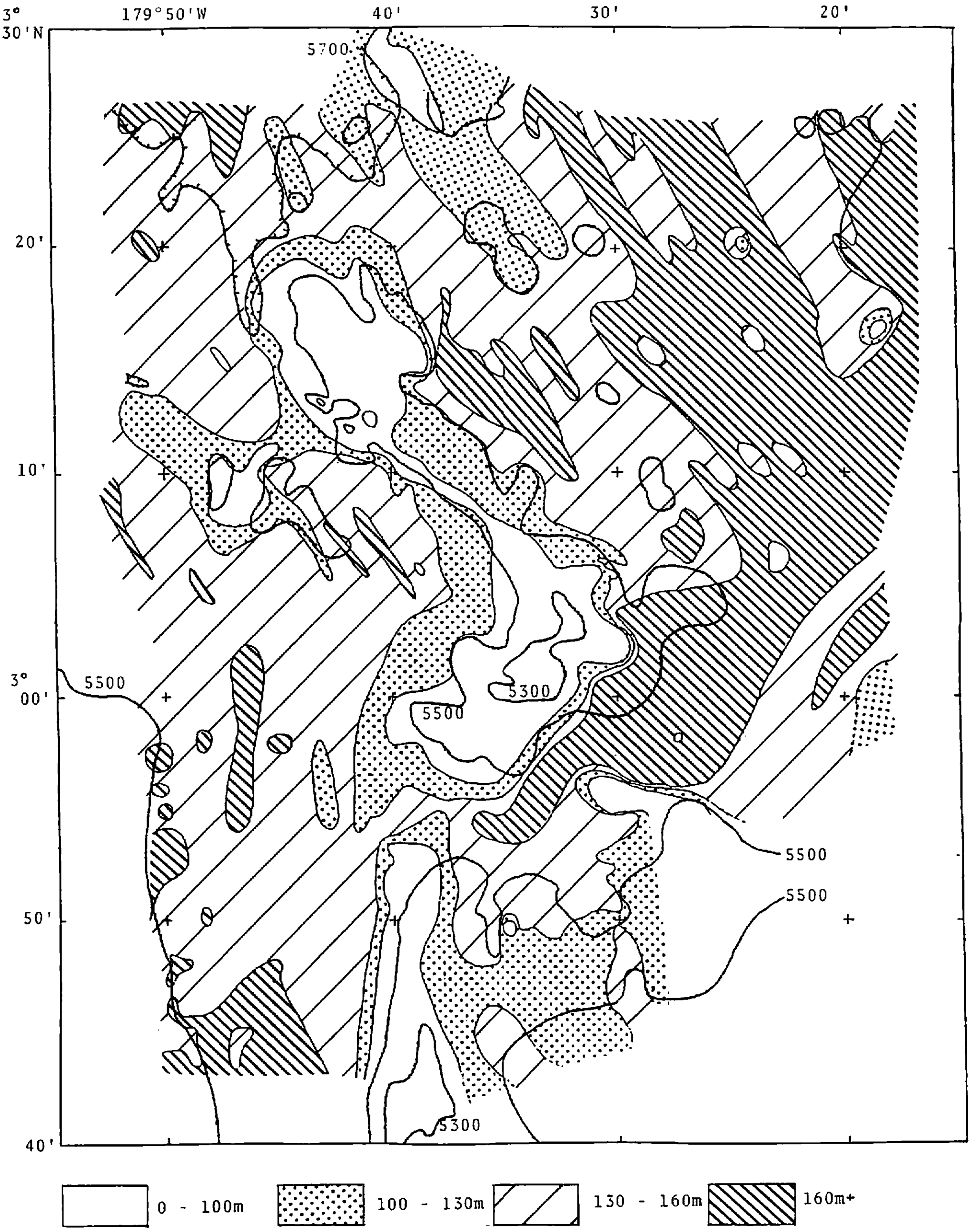

Fig. III-4 Thickness distribution map of the transparent layer in the GH81-4 survey area. In the basin area, it is mainly mapped based on the seismic profiles.

Fig. III-5 Surface acoustic character distribution map in the GH81-4 survey area. A: knoll or topographic high area. B: basement exposed area. C: thin and vague stratification distributed area. D: thick and clear stratification distributed area. E: depression area. F: steep scarp. G: channel.

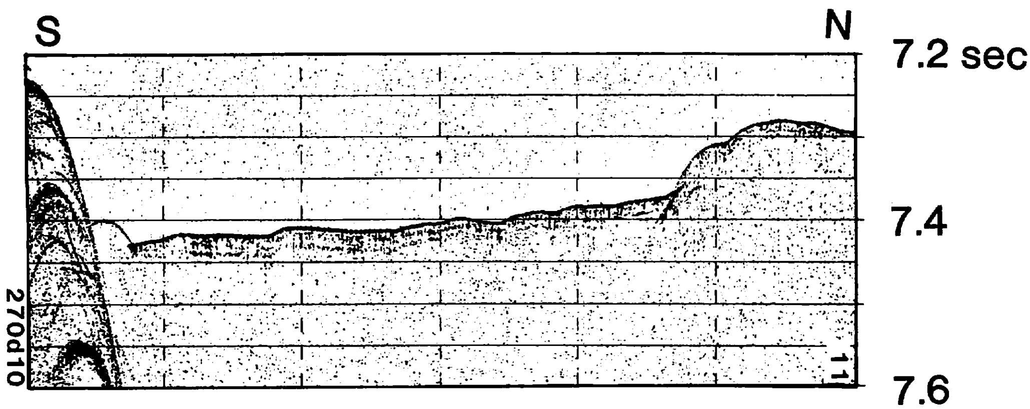

Fig. III-6 Thick and clear stratification in the surficial part of the transparent layer, in the eastern part between northern and southern knolls. Thickness of the stratified part is about 17 m.

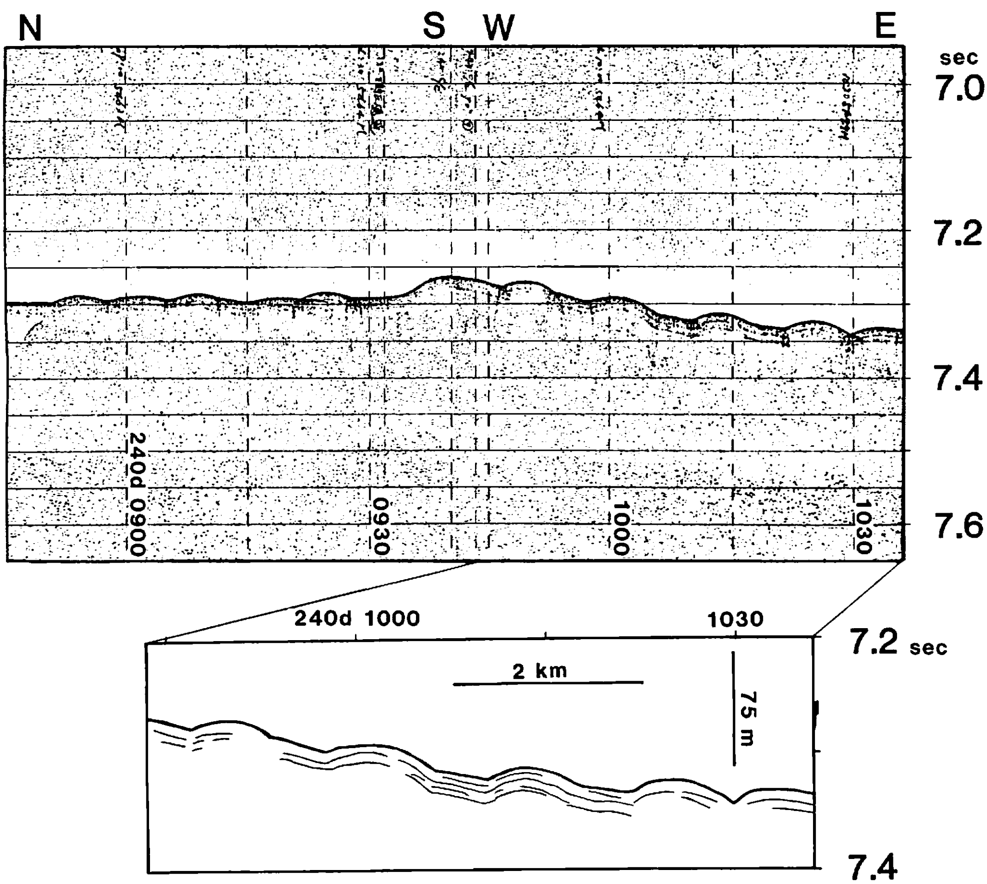

Fig. III-7 Sedimentary waving structure to the west of the northern end of southern knoll. It is difficult to identify the current direction from internal structure. But, the structures are clearer along the east-west survey line than along the north-south one. It suggests that the current direction was possibly eastward.

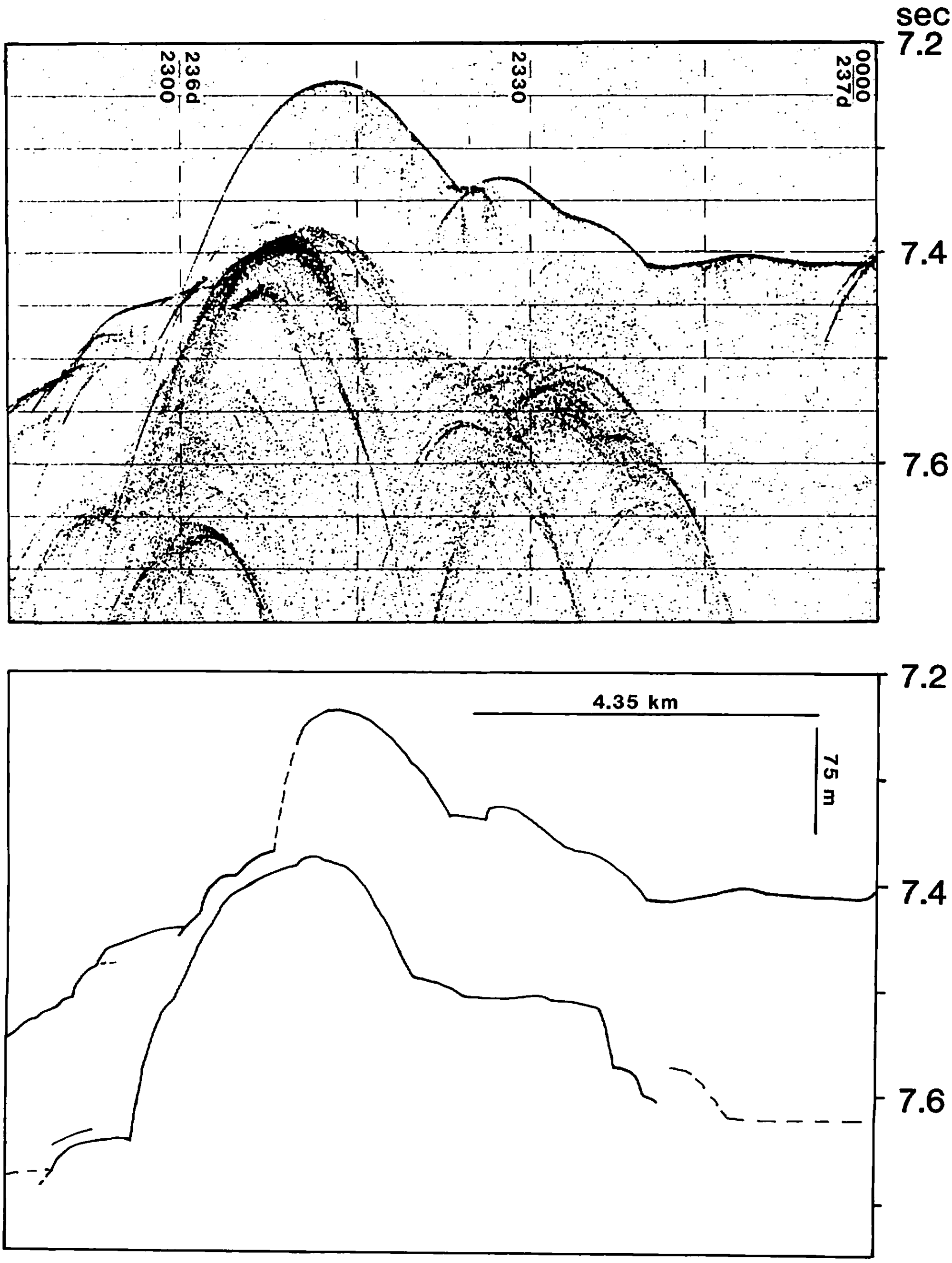

Fig. III-8 Topographic high at the northern end of the GH81-4 survey area. The asymmetry of transparent layer thickness is clear. It is thinner on the western flank of the high, probably by eastward bottom current. This type asymmetry is commonly observed in the survey area.

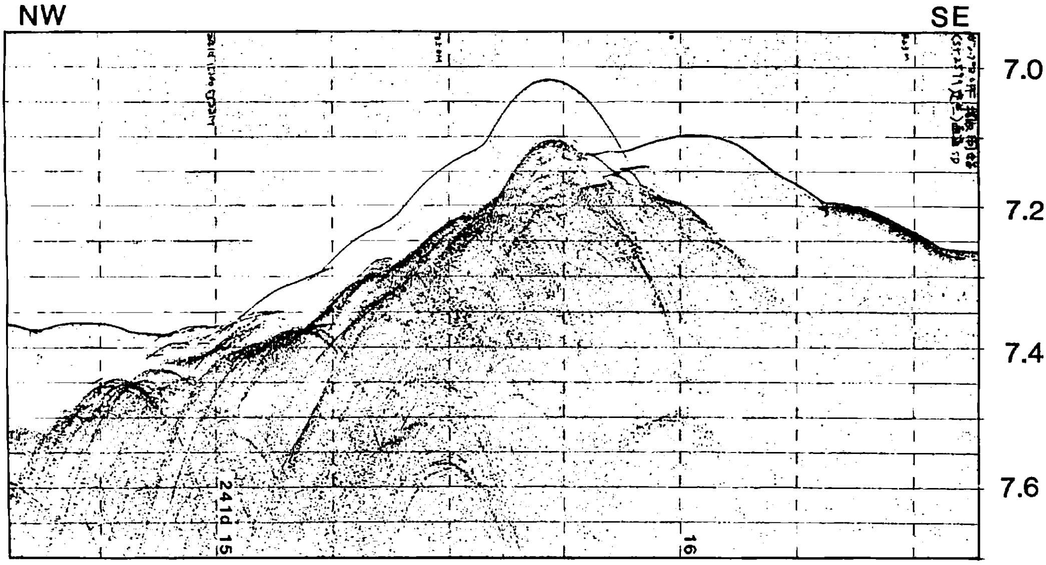

Fig. III-9 3.5 kHz profile across the southwestern branch of the northern knoll. The transparent layer is thinner on the northwestern flank than on the southeastern one. Possible slump structure is developed on the northwestern foot of the knoll. Rugged reflections and many irregular hypabola of acoustic basement suggest that it is composed of volcanic one.

Surface acoustic character distributions are mapped on Fig. III-5. The distinguishable features in the figure are stratification (dense and vague), channel, depression, scarp, and basement exposure.

Basin area

The fine stratification in the surficial part of transparent layer is generally observed in the basin area (Fig. III-6). Dense and thick (15~20 m) stratification is only observed in the area of middle to eastern part between northern and southern knolls. Vague and thin stratification is observed around the area, where the dense and thick stratification is observed, and other scattered area. It probably shows the effect of eastward bottom current between the knolls. The sediments which show the stratification are correlated to siliceous clay or clayey siliceous ooze by the results of piston core P226 (NISHIMURA, in this report).

The waving structure with 100~1,000 m wave length and dozens meter amplitude is observed in the upper part of the transparent layer in some places (Fig. III-7). These waving structures are commonly observed in contourite-depositional area where the thermohaline bottom currents dominate (JOHNSON and DAMUTH, 1979) and in fan lobes which are emplaced by turbidity currents (BOUMA and TREADWELL, 1975). The internal stratification pattern is almost symmetric or irregular and the direction of the currents which form the structure is not identified.

Many small depressions which is fully or partly filled by sediments are observed in the basin area (eastern part of Fig. III-2). There are many small basement high in the

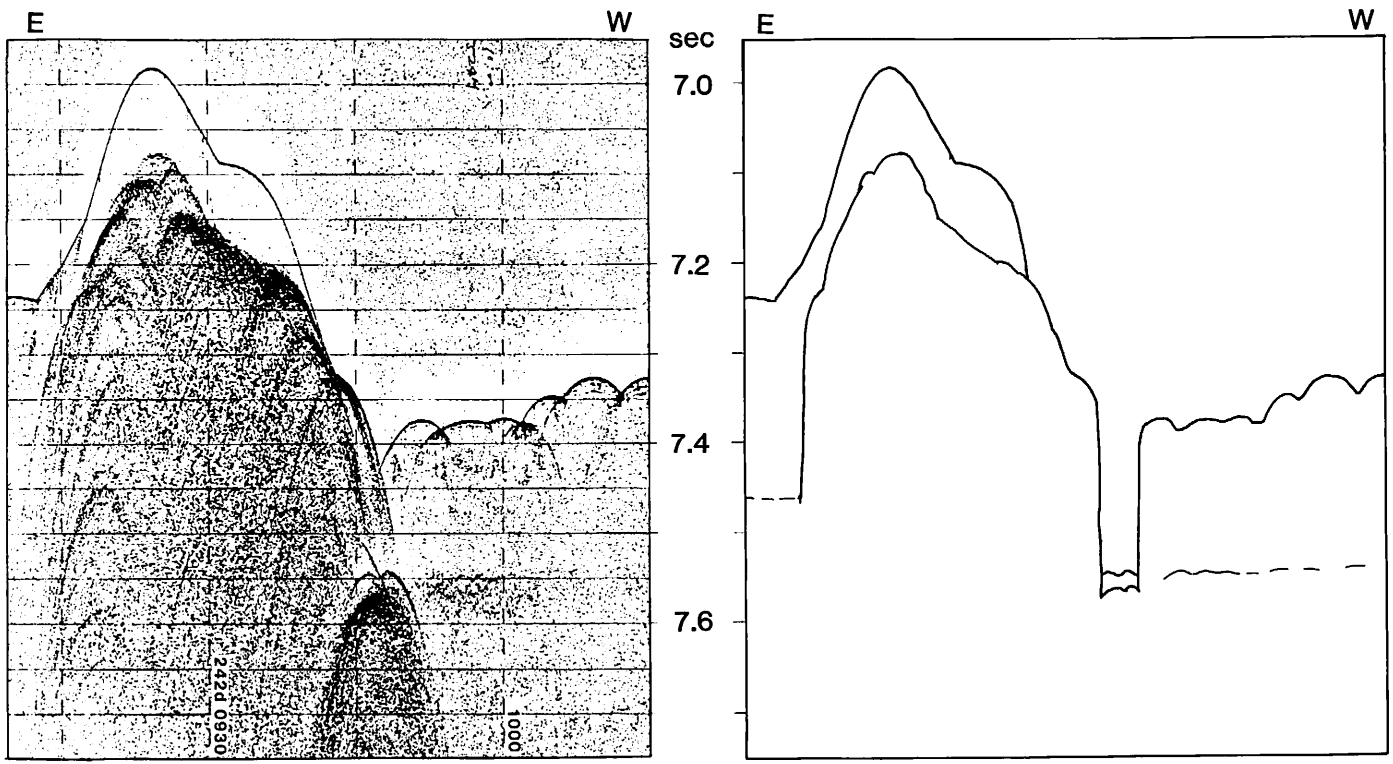

Fig. III-10 The moat-like depression on the western foot of the southern knoll. Thin transparent layer can be observed on the floor. The acoustic basement is exposed on the western flank of the knoll.

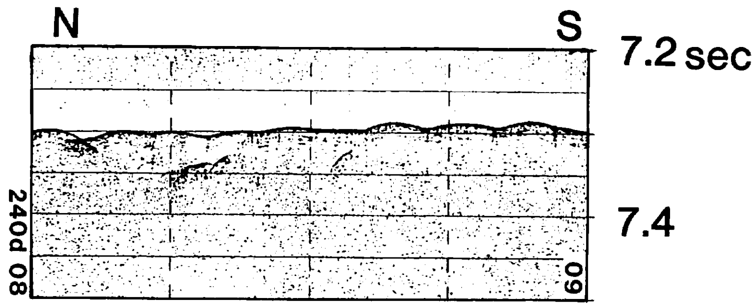

Fig. III-11 Discontinuous and clear reflections in the transparent layer in the basin west of the northern part of the southern knoll. They are possible ancient erosion surfaces.

basin area. The covering transparent layer usually shows asymmetric shape (Fig. III-8). It is thicker in the eastern flank than that in the western flank in general. This fact means the bottom currents flowed from west to east.

Knoll area

There are some basement exposure on the knoll area. The transparent layer is thicker in eastern flank than in western flank, in general (Figs. III-9 and III-10). The thickness is less than that of the basin area and less than 100 m in usual. Some slump structures are observed on the foot of knoll (Fig. III-9). The elongated depression is developed along the western foot of the southern knoll (Fig. III-10). There is thin sediment accumulation in the depression. The depression is interpreted as moat structure which was caused by current erosion. Those moat developed in the foot of topographic high, and the direction is controlled topography and current direction. The moat along the southern knoll is probably developed by the bottom current from southwest~south to the knoll wall.

Bottom current activity

Some bottom current origin sedimentary structures are observed in the GH81-4 survey area. They are moat, sediment wave, fine stratification, and asymmetric thickness distribution on and around the topographic high. Some surficial structure of transparent layer shows the current is still active in geological time scale. The current probably not turbidity current because that it mainly affected to the slope of knoll and that distributed sediment is not restricted by the topographic low. The southwest~west to northeast~east current direction is possibly dominant.

Possible historical eroded feature, discontinuous flat strong reflector, in transparent layer are observed in the scattered areas (Fig. III-11). It may show the some change of bottom current system during the transparent layer deposited, that is post Oligocene.

Relationship between manganese nodule distribution and sedimentation

The relation between thickness of the transparent layer and abundance of manganese nodules is shown in Fig. III-12. Classification of the manganese nodules is based on Usui (in this report). The maximum amount of s-type nodule at each

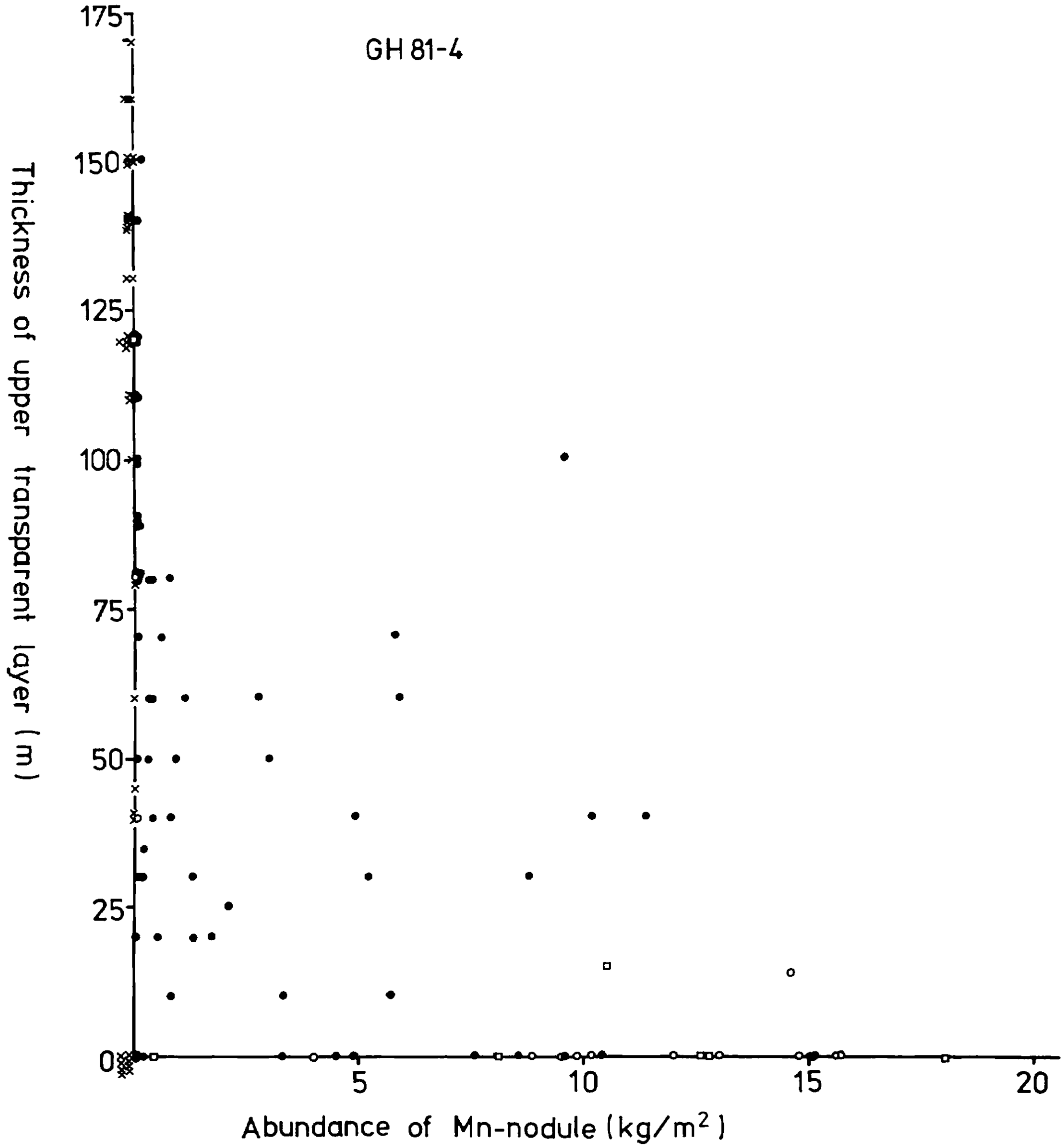

Fig. III-12 The relationship between abundance of Mn-nodules and the thickness of upper transparent layer in the GH81-4 survey area. Solid circle: s-type nodule. Open circle: r-type nodule. Open square: i-type nodule. x: no nodule.

thickness of the transparent layer shows rough reverse correlation with the thickness of the transparent layer. Most of r-type nodule develops in the area where no transparent layer is recognized. The relation between the thickness of transparent layer and of i-type nodules is similar to that in case of r-type nodules. Manganese nodules are rare or scarce in the areas where the transparent layer is thicker than 100 m.

These relations are quite similar with those which were pointed out by previous study in the Central Pacific Basin (TAMAKI *et al.*, 1977). The relation gives the guideline in prospecting of manganese nodule in this area.

References

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JOHNSON, D. A. and DAMUTH, J. E. (1979) Deep thermohaline flow and current-controlled sedimentation in the Amirante Passage: Western Indian Ocean. *Marine Geology*, vol. 33, p. 1–44.

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