Chapter 3 Results of the Survey

Cobalt-rich crusts were surveyed on the seamounts in two areas, MC11 and MS13, in the eastern waters, and also in two areas, MC12 and MC13, in the western waters during this fiscal year.

In addition, the occurrence of hydrothermal deposits were surveyed in the MS02 area where the possibility was pointed out by the results of last year survey.

3 - 1 Topographic Survey

(1) Outline of topography

The Federated States of Micronesia is located immediately north of the equator in the western Pacific, and comprises the Caroline Islands which extends in the east-west direction and the Yap Islands which lies adjacent to the Carolines toward the west. The Palau Islands are located to the southwest of the Yap Islands and the Mariana Islands including Guam are to the northeast. The Marshall Islands are located to the east of the Caroline Islands (Fig. 3-1-1).

There are many oceanic islands, atolls, seamounts, and guyots within the Caroline Islands. The seafloor of the western sea has complex geologic structure with a trench, troughs, oceanic ridges, and oceanic plateaus. The major structural directions are; NNE-SSW of the Mariana Trench, WNW-ESE of the Caroline Ridge and Sorol Trough, and E-W of the Eauripik Trough. The islands and the seamounts are distributed on the ridges and plateaus which extend in the WNW-ESE ~ WSW-ENE direction. And the islands and seamounts generally spread out east-westward in belt-like pattern.

On the other hand, the islands and the seamounts in the eastern sea occur independently and sporadically in the WNW-ESE direction.

(2) Classification and topographic division of seamounts

These seamounts were classified as listed in Table 3-1-1. And the topography of these seamounts were divided into the summit and the slope considering the features shown in Table3-1-2 and Figure 3-1-2. The slopes of individual seamounts were further divided in accordance with topographic gradient. The water depth distribution of the summit and slope, however, differs by individual

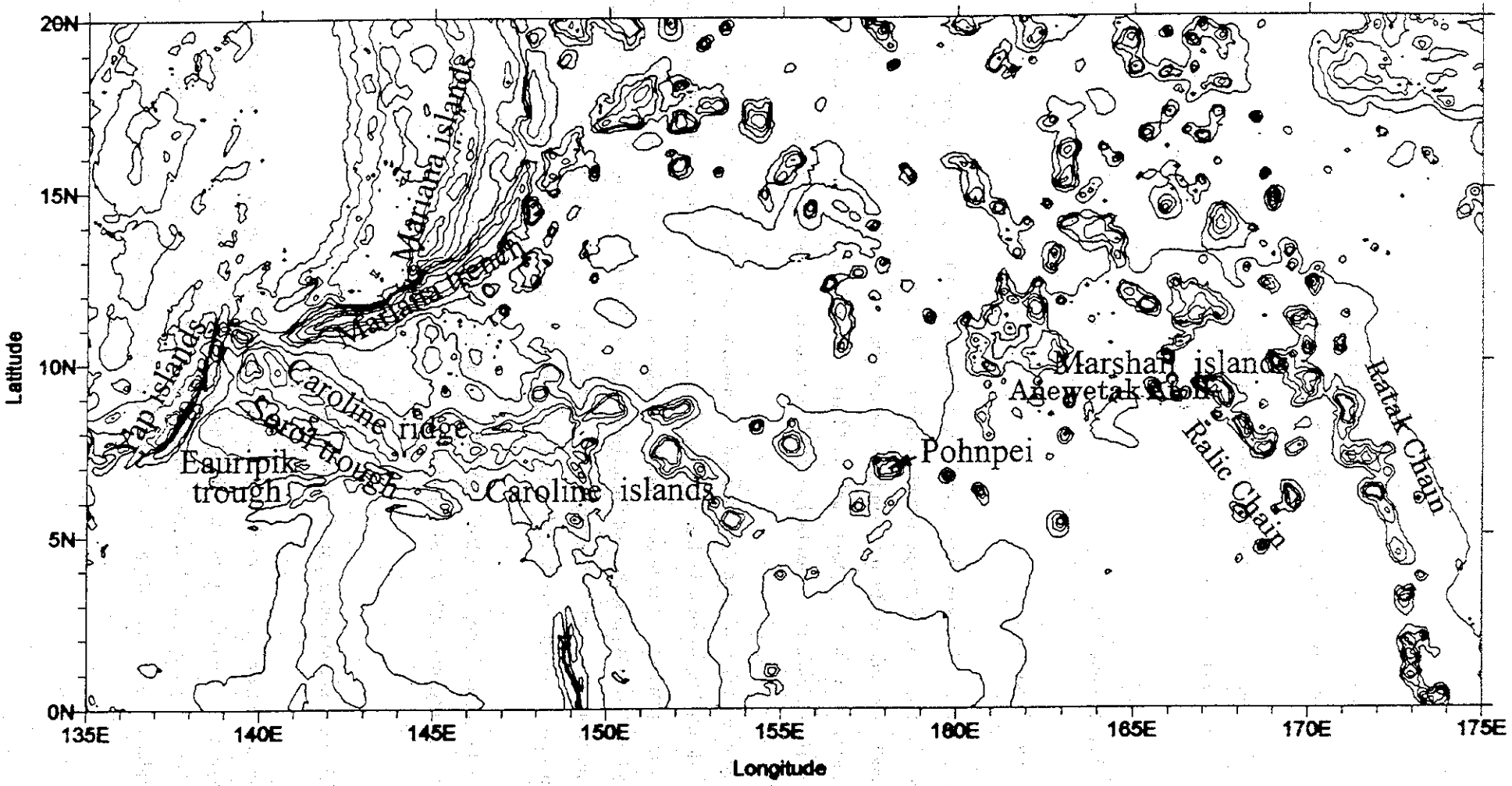


Fig. 3-1-1 Structural map around the survey area

Table 3-1-1 Topographic Classification of Seamount

Classification	Characteristics of Shape
Table Seamount(guyot) Dome summit Flat summit Angular summit	Seamount with summit comparatively flat and horizontal Summit part has relative height with over 300m contour. Summit part has relative height less than 300m contour. Summit part is large but undulated.
Ridge-shaped Seamount	Seamount extended in one direction like a ridge
Plateau-shaped Seamount	A kind of table seamount whose summit is largely flat
Peaked Seamount	Seamount with little flat or horizontal part on summit

Table 3-1-2 Subdivision of Seamount

Classification		Topographical Characteristics
Summit	Central part	Central part of the summit with flat or gentle topography
	Marginal part or Periphery	Transitional zone from the central part of summit to the upper part of slope
Slope	Upper part	Steeply inclined upper part of slope
	Middle part	Area between the upper and lower part of slope
	Lower part	Gently inclined lower part of slope
Foot of seamount		Transitional zone from the lower part of slope to the ocean floor

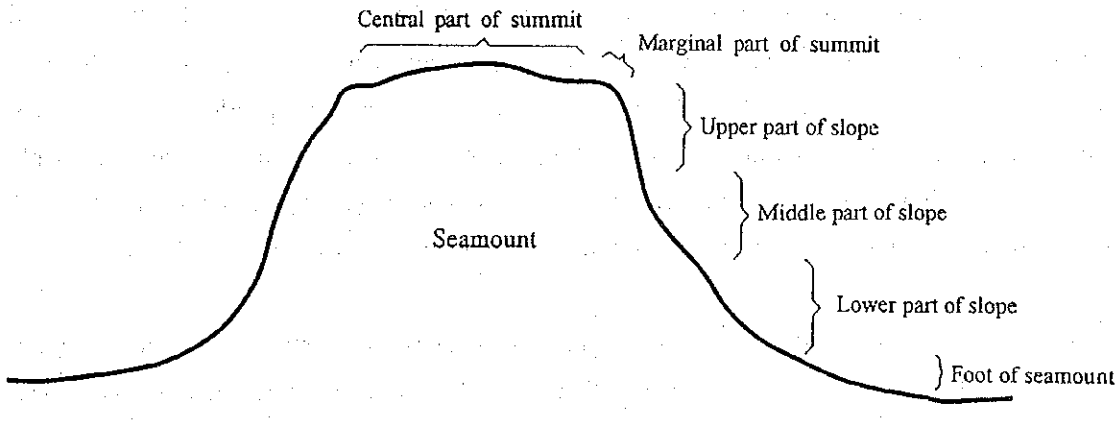


Fig.3-1-2 Schematic model of seamount subdivision

seamounts and thus topographic division by water depth has not been made.

(3) Results of topographic survey

The characteristics of individual seamounts are laid out in Table 3-1-3. The topographic statistics related with topographic division of individual seamounts are laid out in Table 3-1-4. It is seen from Table 3-1-3 that the type of seamounts in the present study area are; in the eastern sea, the seamount in MC11 area is a guyot with dome-shaped summit, and that in MS13 area is a rugged guyot with summit with high relief; and in the western sea, those in MC12 and MC13 are unique type without not-clear flat summit, that in MC12 is ridge-like seamount, and that in MC13 has plateau-type topography.

The seamount in MC11 area is a small guyot with a dome-shaped summit. There are several pinnacles at the central part of the summit, but topographic section show a very smooth seafloor formed by unconsolidated sediments.

The seamount in MS13 area has many pinnacles in the central part of the summit. The pinnacles arranged along the long axis are particularly notable and the summit has high relief. Therefore bedrock exposures are abundant and unconsolidated sediments thinly cover the depressions in-between the pinnacles.

The topography of the seamounts in areas MC12 and MC13 are different from those in other areas. Particularly the summit of MC12 seamount consists of ridges continuous in the E-W direction and has oceanic ridge type of topography. Thus unconsolidated sediments are hardly observed with the exception of the collapsed zone. MC13 seamount is located on an oceanic plateau. The seamount has steep cliff extending in the E-W direction on the northern side and a gentle slope on the southern side, and the seamount topography is, on the whole, not clear and appears like a small oceanic plateau. The summit, however, has many reliefs and thus constitutes a relatively rugged seafloor. Unconsolidated sediments cover the whole summit, but it is very thin on the raised parts.

Bird's-eye view of the seafloor topographic maps of the above seamounts is laid out in Figure 3-1-3(1)~(4), bathymetric maps in Appended Figure 2 (1)~(4), and topographic gradient maps in Appended Figure 3 (1) ~(4).

The following is the characteristics of individual seamounts.

Table 3-1-3 Characteristics of Seamount

Area	Location	Type	Shallowest Depth (m)	Base Height (m)	Relative Height (m)	Seamount size (above 3,000m) long axis×short axis (km) long axis direction	Summit area (km2)	Slope area (km2) (above 3,000m)	Seamount characteristics
MC02	9°00′ N·141°30′ E	Oceanic plateau seamount.	1,080	3,500	2,400	E－W	1,134	1,838 (Shallower than 3,300m)	Steep slope extend E-W on north side. Summit covered by sediments. Pinnacles on SE part of summit.
MC11	10°55′ N·161°27′ E	Guyot.	1,777	4,800	3,020	13×23 NNW－SSE	94	265	Summit dome topography 300m relative height. Shallowest eastern pinnacle. Terrace shallower than 3,000m extends in long axis direction on northern part.
MC12	9°20′ N·146°05′ E	Oceanic ridge seamount.	1,141	3,800	2,760	45×20 WNW－ESE	35	797	Summit dome topography 300m relative height. Shallowest eastern pinnacle. Terrace shallower than 3,001m extends in long axis direction on northern part.
MC13	10°20′ N·145°00′ E	Oceanic plateau seamount.	1,656	3,800	2,140	40×35NW－SE	828	1,382	Shallowest part of plateau, above 4,000m. NE side steep from 2,500m shoulder to base, but other parts gentle slope to base.
MS13	10°20′ N·145°00′ E	Rugged seamount.	1,387	5,000	3,610	25×50 NNE-SSW	1,112	1,417	Summit rugged, sediments scarce except northern part. Ridges extend in NE and NW parts. NE ridge continues to seamount in N.

Table 3-1-4 Topographic Division and Gradient

Areas	Division	Water depth range (m)	Slope area (km^2)	Average grandient (°)	Minimum gradient (°)	Maximum gradient (°)	Frequency distribution of gradient (%)			
							0-10	0-20	20-30	30 <
MC02	Summit	< 1,400	295	3.7	0.1	31.8	92.5	5.9	1.6	0.0
	Upper Slope	1,400 < 2,000	167	21.0	1.2	44.7	6.6	34.8	50.5	8.1
	Middle slope	2,000 < 3,000	467	17.9	0.4	50.5	10.9	53.4	32.0	3.7
	Lower slope	3,000 < 4,500	156	10.5	0.1	44.2	57.5	31.7	10.0	0.8
MC11	Summit	< 2,500	94	7.5	0.1	31.7	80.2	12.2	7.2	0.5
	Upper Slope	2,500 < 3,000	171	13.4	0.4	48.6	39.8	40.0	16.4	3.8
	Middle slope	3,000 < 3,500	318	12.9	0.3	48.6	36.5	48.8	14.0	0.7
	Lower slope	3,500 <	1227	9.3	0.0	40.9	61.2	31.1	7.2	0.6
MC12	Summit	< 1,500	35	17.1	0.7	36.1	17.3	45.1	34.9	2.3
	Upper Slope	1,500 < 2,000	101	16.2	0.8	43.9	19.2	51.5	25.8	3.5
	Middle slope	2,000 < 2,500	225	12.8	0.1	35.4	37.1	48.5	13.3	1.0
	Lower slope	2,500 <	1540	6.8	0.1	42.7	77.5	19.6	2.7	0.2
MC13	Summit	< 2,500	828	6.9	0.0	42.7	80.4	15.7	2.9	1.0
	Upper Slope	2,500< 3,000	554	9.5	0.1	44.0	64.5	26.2	8.0	1.3
	Middle slope	3,000 <3,500	741	7.0	0.1	43.0	77.8	17.0	4.9	0.4
	Lower slope	3,500 <	313	4.7	0.0	33.2	84.8	9.2	2.0	0.3
MS13	Summit	< 2,700	1122	9.0	0.0	68.2	66.3	26.0	7.3	0.4
	Upper Slope	2,700 < 3,500	794	14.4	0.0	70.2	36.8	37.4	21.3	4.5
	Middle slope	3,500 < 4,000	747	11.0	0.1	71.3	53.8	31.0	14.0	1.1
	Lower slope	< 4,000	1067	8.2	0.0	33.4	67.6	27.0	5.2	0.2

<Eastern Sea>

1) MC11 area

The seamount of this area is small guyot centered around 7° 30'N, 161° 18'E located 260 miles south-southeast of the Anewetak Atoll. The shallowest part is 1,777m deep from the sea surface and the relative height from the base is approximately 3,000m. The axis of the seamount extends in the NNW-SSE direction and planar section at 3,000m water depth has oblong shape with 23km in long axis 13km in short axis, but the flat summit zone above 2,500m water depth is circular with about 12km diameter. The summit has an average slope of 3° forming a gentle dome from the periphery rising to the central part. The summit is covered entirely by sediments with the exception of pinnacles. The center of the summit is offset to the southern part of the seamount and thus the upper southern slope is very slope exceeding 30° gradient. On the other hand, the northern slope extending in the NNW direction forms a terrace at 2,700~3,000m of water depth and has a gentle average gradient below 10° . But the seafloor is relatively uneven and many bedrock exposures are observed.

The middle slope at 3,000~3,500m of water depth has relatively gentle gradient with many pinnacles. On the northeastern side, a large terrace is formed at 3,700~3,900m of water depth and protrusions attaining relative height of 800m are observed on the terrace surface.

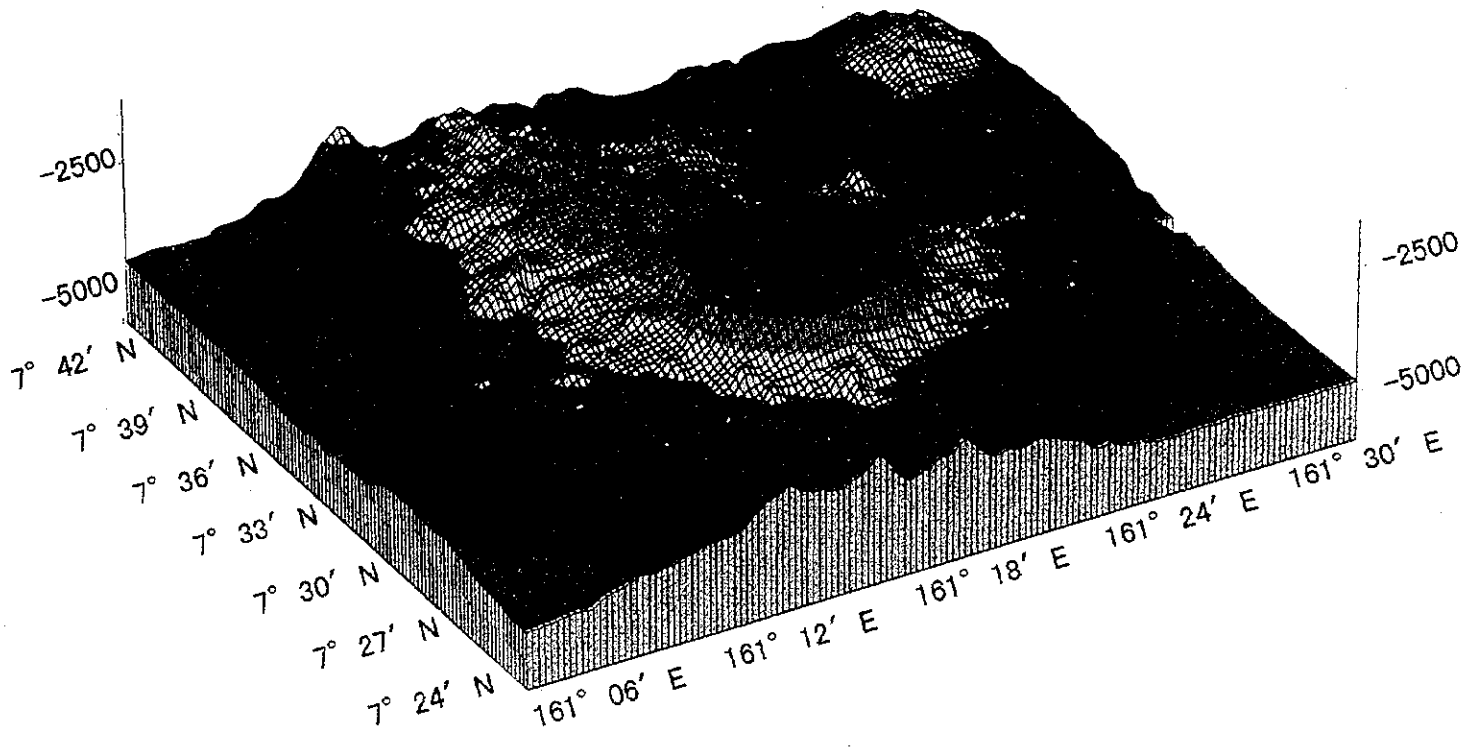


Fig.3-1-3(1) Bird's eye view of bathymetry of MC11 area.

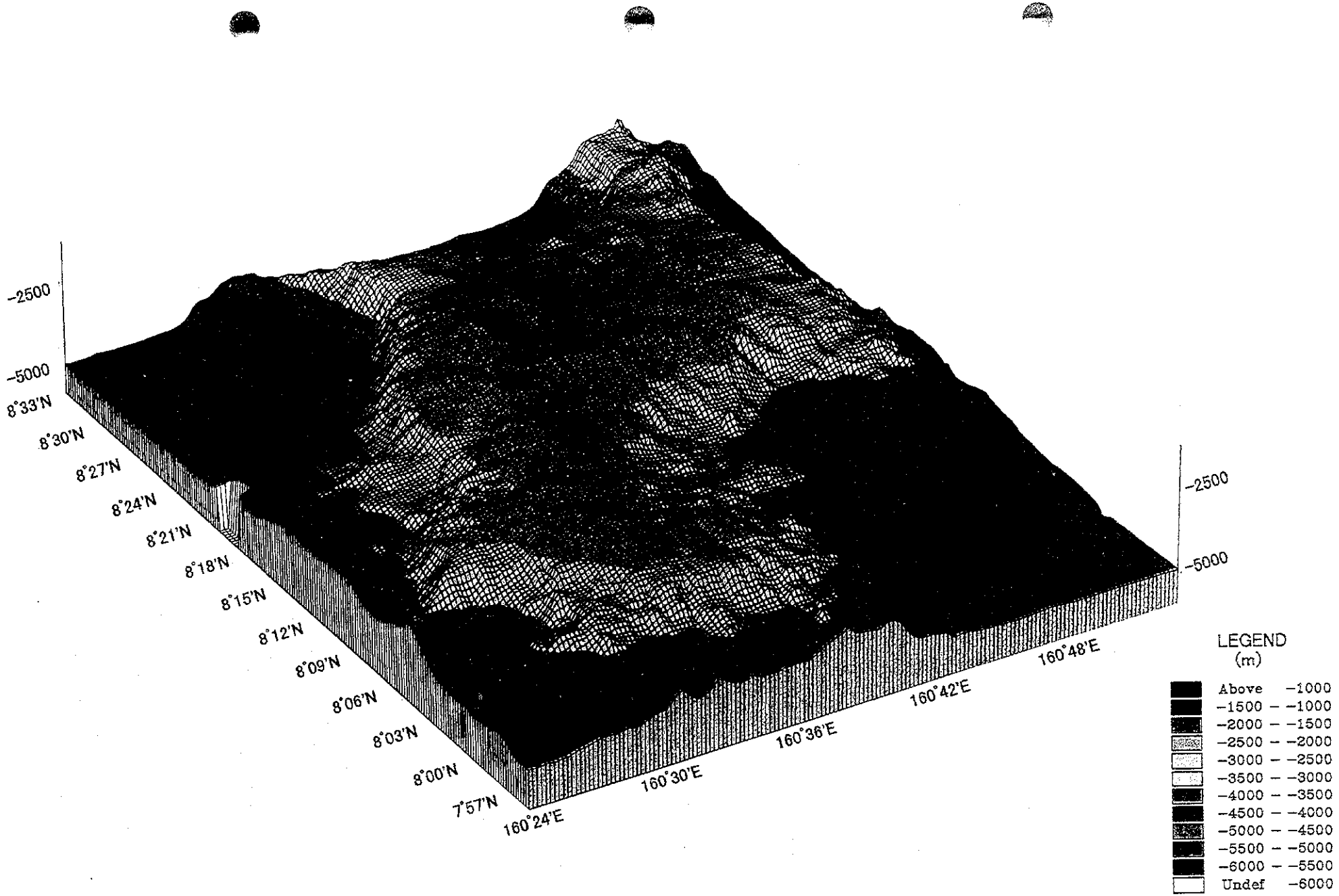


Fig.3-1-3 (2) Bird's eye view of bathymetry of MS13 area.

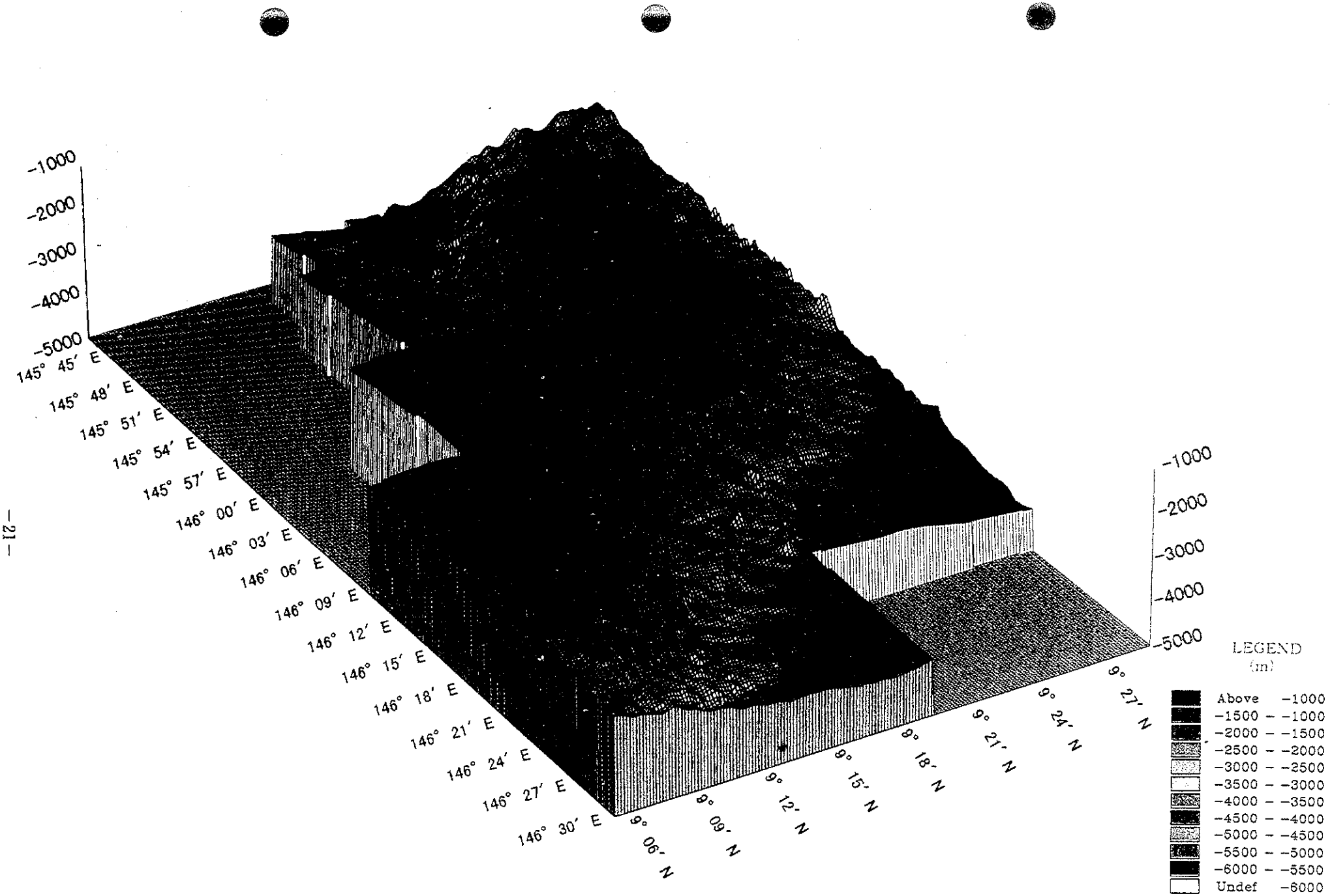


Fig.3-1-3 (3) Bird's eye view of bathymetry of MC12 area.

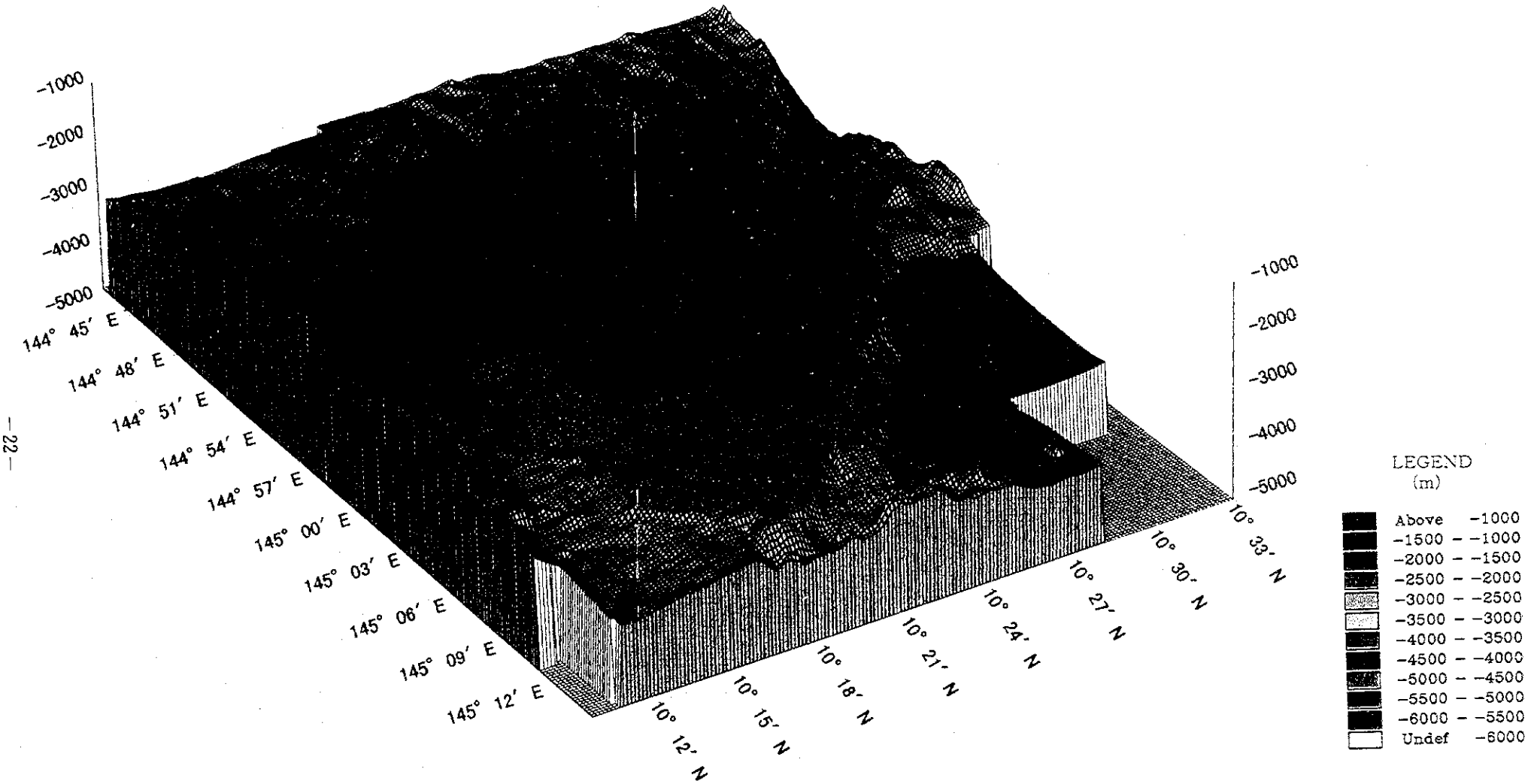


Fig.3-1-3 (4) Bird's eye view of bathymetry of MC13 area.

2) M S 13 area

The seamount in this area is located at 08° 15' N, 160° 40' E. Although this is classified as a guyot, the summit has notable relief with many pinnacles and rises. Thus this is classified as a rugged guyot. The shallowest part is near the center of the summit and the top of the pinnacle is 1,387m in water depth. The relative height from the base is approximately 3,600m.

The shape of the summit is rectangular with approximately 50km long axis in the NNE-SSW direction and 25km short axis. The width of the summit narrows and the topography becomes complex to the south. The areal extent of the seamount at 2,700m water depth zone is 1,122km^2. The inclination of the summit is relatively steep for a guyot because of the pinnacles and other protrusions and the average is approximately 9° .

The average gradient of the slope is lower than other guyots by the effect of terrace topography at 14.4° in the upper part and 11.0° in the lower part. The slope to the north of 8° 20' N and the ridges extending in the northwestern and northeastern parts, however, are steep exceeding 30° as shown in the gradient map of Table 3-1-4.

There is another seamount 30 miles northeast of this guyot and it is inferred that the ridge extending northeastward connects to it.

<Western Sea>

1) MC12 area

The seamount in this area has ridge type topography and is located with its center at 9° 20' N, 146° 05' E. Its long axis extends for about 60km in the N70° W direction, and the relative height from the base is about 2,800m. The central part of this seamount is about 20km wide and narrows gradually to the east and west. Corral reef is formed on the summit and it is 2km wide and 18km long with the shallowest part 1,141m below the sea surface. The pinnacles occur throughout the summit without flat space and unconsolidated sediments cover very little. There is a collapsed topography on the upper southern slope, and it is inferred that unconsolidated sediments occur there from the MBES acoustic pressure.

To the southeast of this seamount, there is a ridge-type high extending in the NW-SE direction. Its summit is 2,100m in water depth and is lower than the seamount with a gentler slope and has abundant unconsolidated sediments. The seafloor is very smooth from the flat zone to the west of this ridge to the 2,500m deep slope south of this seamount.

2) MC13 area

The seamount in this area is centered around 10° 20' N, 145° 00' E, and is the high on an oceanic plateau 4,000 below the sea surface. This is classified as a plateau-type seamount. Only a part of this seamount is expressed in the topographic map and the total seamount cannot be observed. The western slope particularly extends widely and gently to the base, and thus the zone shallower than 3,000m was the object of the present investigation. On the southern slope, there is a high on the gentle slope forming a saddle, the area to this saddle was the object of investigation.

The summit of this seamount is not clear, and if the zone to 2,500m of water depth is considered as the summit, its areal extent would be 828km^2, and would become a seamount with a relatively large summit. The shallowest part is the high at the northern summit periphery with 1,656m of water depth and 2,200m of relative height from the base. The summit extends in the N-S direction, while the topography of this area has a NW-SE trending structure. The slope which steeply drops in the northeastern side is parallel to this structure. Also the MBES acoustic reflection intensity distribution map - to be mentioned later - show several linear structures parallel to this direction.

The summit is widely covered by unconsolidated sediments with the exception of the northern edge and the high at the eastern periphery, and the high in the central part is also covered by unconsolidated sediments. Thus the relief of the summit is large but the seafloor is relatively smooth.

3 - 2 MBES Acoustic Reflection Intensity Distribution Map

(1) Acoustic reflection intensity distribution of individual seamounts

The distribution of the MBES acoustic reflection intensity from the seafloor of each area is shown in Figure 3-2-1 (1)~(4).

The acoustic reflection intensity from the seafloor obtained by MBES reflect the conditions of the seafloor such as exposed rocks and unconsolidated sediments. The exposed rocks show high acoustic reflection intensity and is expressed in dark color (black) in the map, while unconsolidated sediments show low intensity and is expressed in pale color (white). When gravel and nodules occur on the unconsolidated material or when the unconsolidated sediments are coarse grained, the area is expressed in intermediate color (gray).

The four seamounts surveyed this year are all of different types; guyot, rugged guyot, ridge-type seamount,

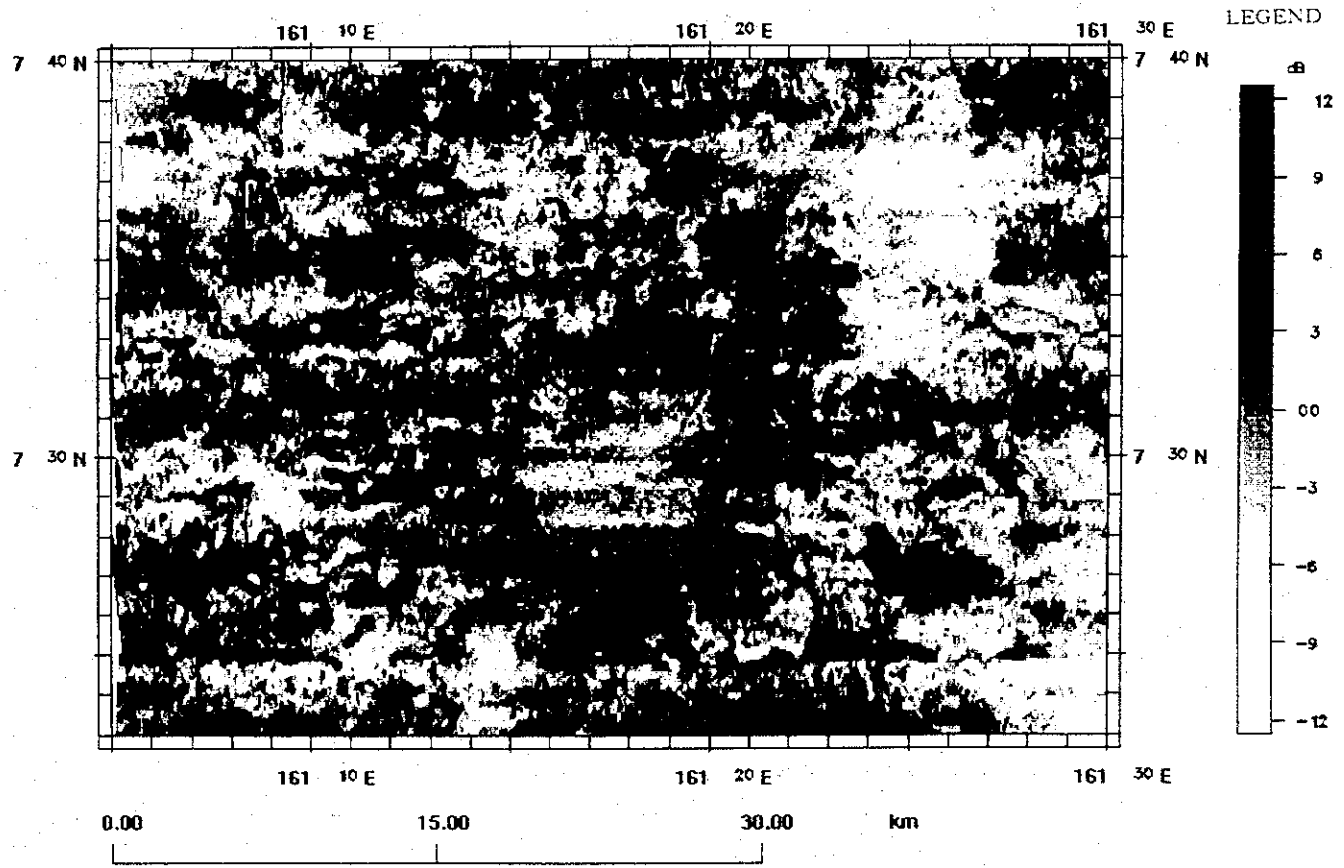


Fig.3-2-1(1) Acoustic reflection intensity distribution of MC11 area.

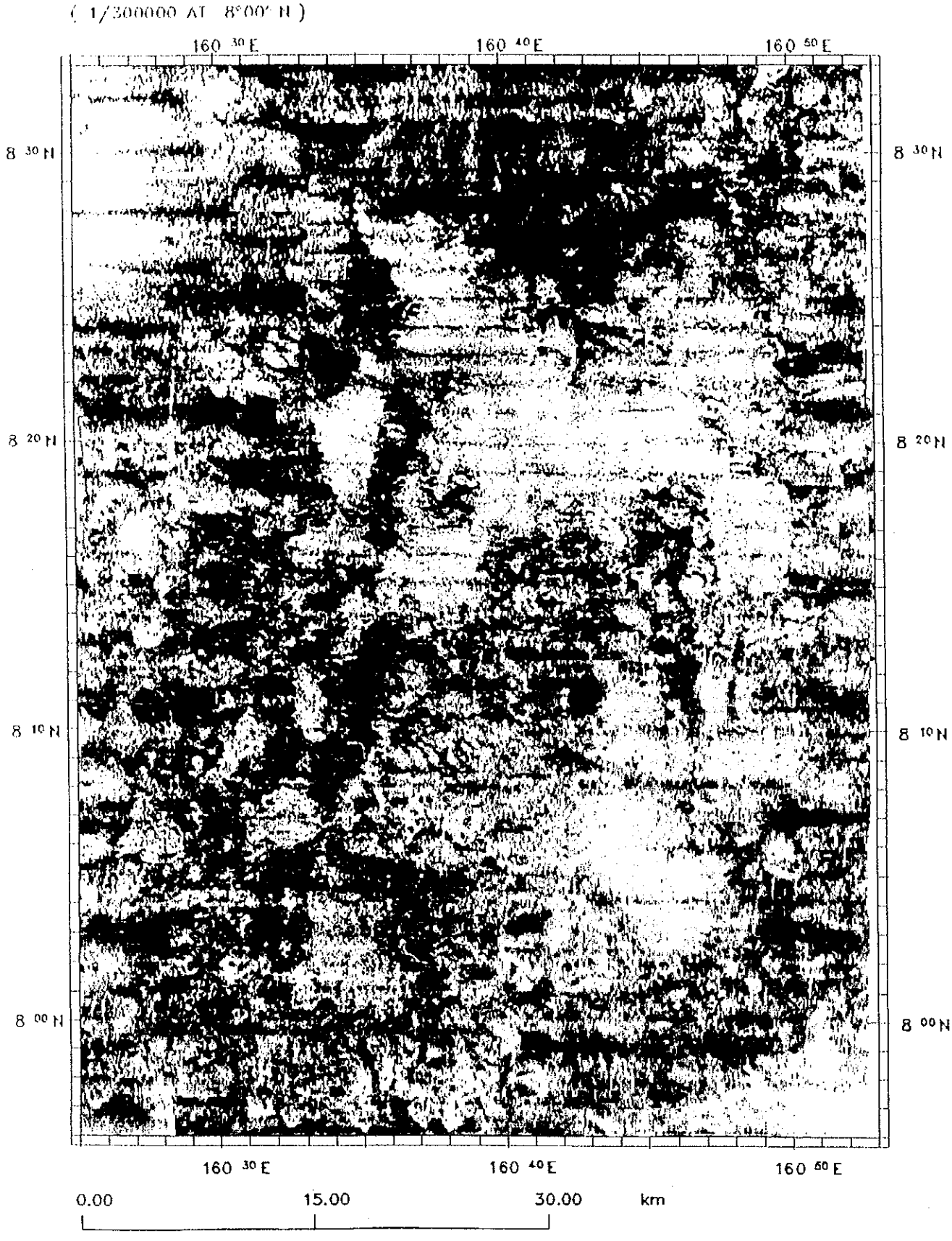


Fig.3-2-1 (2) Acoustic reflection intensity distribution of MS13 area.

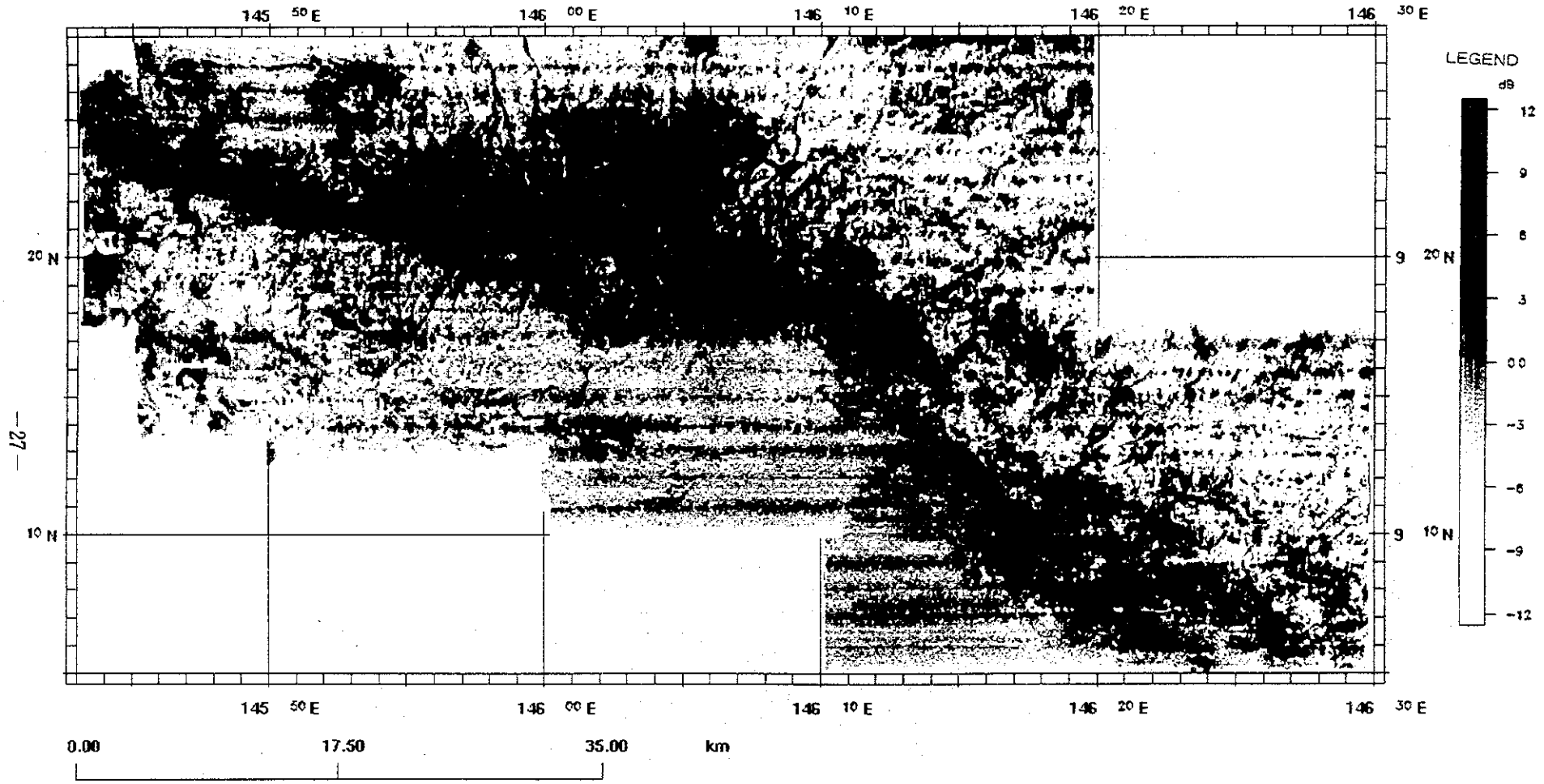


Fig.3-2-1 (3) Acoustic reflection intensity distribution of MC12 area.

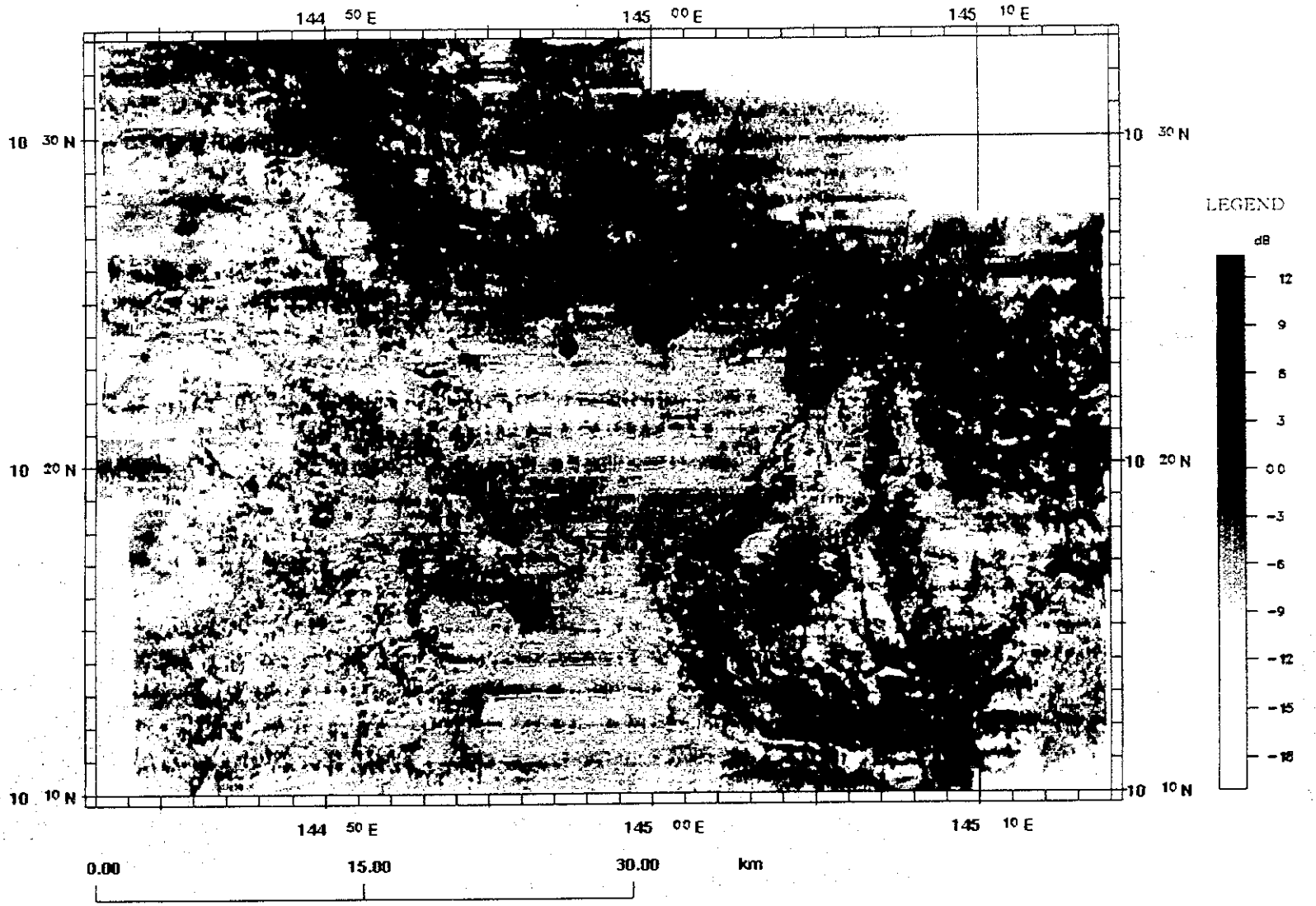


Fig.3-2-1 (4) Acoustic reflection intensity distribution of MC13 area.

and plateau-type seamount and the acoustic reflection intensity distribution differ significantly by individual seamount.

The whole summit of the guyot in MC11 area is covered by unconsolidated sediments and the acoustic reflection intensity is low with pale-colored image extending over the entire summit.

The seamount in area MS13 which is classified as rugged guyot, has many pinnacles in the central part of the summit, and the unconsolidated sediment cover is thin. The acoustic reflection intensity map show complex pattern with alternating dark- and pale-colored parts indicating the exposures of the pinnacles and unconsolidated sediments in the depressions between the pinnacles.

The ridge-type seamount in MC12 area is expressed in dark image indicating exposed rocks in the whole area from the summit to the slope with the exception of parts of valleys.

The summit of the plateau-type seamount in MC13 area is generally shown in pale image indicating unconsolidated sediment cover with the exception of the north to eastern slope where dark image is observed.
The characteristics of the MBES acoustic reflection intensity distribution of individual seamount is reported below.

<Eastern Sea>

1) MC11 area

Pale-colored image with low acoustic reflection intensity corresponding to unconsolidated sediments are widely distributed in the central part of the summit which forms a gentle dome.

Significantly dark image with high reflection intensity occurs at the northeastern part of the summit corresponding to the pinnacles. Also high acoustic pressure is distributed at the periphery of the summit corresponding to exposed bedrock.

Acoustic pressure tends to decrease downward on the slopes, and it is particularly low at the western upper slope where unconsolidated sediments are believed to be distributed over the whole slope.

Pale image corresponding to unconsolidated sediments is distributed generally over the wide terrace at 2,700~2,800m water depth in the northern side with high acoustic pressure parts corresponding to pinnacles which occur sporadically on the terrace. Also the lower slope below 3,500m water depth is expressed in pale tone indicating wide coverage of sediments.

2) M S 13 area

The summit of this seamount has very complex topography with large relief consisting of many pinnacles and other protrusions. Thus the acoustic pressure is not even and the image shows complex distribution corresponding to the topographic relief. The topography is particularly complex in the summit south of 8° 20'.

In the western margin of the summit, there are two rows of pinnacles extending parallel to the long axis and the corresponding high acoustic zones are striking. Dark parts indicating bedrock exposures are distributed all over the image with pale parts corresponding to unconsolidated sediments distributed locally between the pinnacles and in depressions.

Unconsolidated sediments are prevalent to the north of 8° 20' and the seafloor is relatively smooth. SBP records show that the thickness of these sediments attain 100m in some places. Also low acoustic pressure zones indicating the presence of unconsolidated sediments occur on the wide terraces at 2,500~2,700m water depth in the northern to northeastern part, and at 3,500m water depth in the southeastern part. The image of the southeastern terrace has the most pale color tone and the sediments are considered to be particularly thick.

<Western Sea>

1) MC12 area

The seamount in this area has an oceanic ridge topography without flat summit. Thus the zone from the summit to the upper slope is steep and the distribution of the unconsolidated sediments is very limited. In the southern slope, however, valleys are developed and they form low acoustic pressure zones and unconsolidated sediments are considered to occur. Also the gentle slope below 2,500m water depth has undulating topography and acoustic pressure is generally weak and unconsolidated sediments are probably widely distributed.

There is a horst-type high with small relative height with NW-SE axis in the southeastern part of the seamount, and its summit is relatively flat and show low acoustic pressure indicating the accumulation of unconsolidated sediments. High acoustic pressure zones indicating rock exposures occur parallel to the axis on both sides of this low acoustic pressure zone.

The flat zone extending to the west of the above horst-type high has low relief and the seafloor is very smooth in the acoustic reflection distribution map.

2) M C 13 area

The seamount in this area is a high ground located on an oceanic plateau. The summit is wide, and pale image indicating the distribution of unconsolidated sediments extends over the entire summit. Also the western side is a gentle slope continuing from the summit to the base and it is totally covered by unconsolidated sediments. Therefore, it is not possible to distinguish clearly the summit and the slope on the acoustic reflection distribution map. As mentioned earlier, however, it is seen from the SPB record that the sediment cover on the high zone is thin, and the sediments are not developed sufficiently to completely level the seafloor.

On the other hand, in the northeastern to the eastern part of the seamount the slope drops precipitously from the summit to the base, and dark image indicating exposed rocks appear on the summit periphery. The cliff is linear and is composed of lineaments with NW-SE axis, NE-SW axis and that with E-W axis controlled by these two lineaments.

There are pinnacles and N-S trending protrusion in the eastern part of the summit periphery, the acoustic pressure is high and it is inferred that rocks are exposed to the slope. Valleys are developed on the slope on the southern side of these pinnacles and dark images indicating high acoustic pressure extends from the valley slope to the base.

On the western slope, several linear structures with high acoustic pressure are observed parallel to the NW-SE lineament.

3 - 3 SBP Survey

(1) SBP analysis

SBP survey was carried out in order to clarify the distribution of the sediments under the seafloor. Although nSBP used has high record resolution, it is not possible to obtain reflection from seafloor with more than 5° inclination. Therefore the survey was carried out from the summit to parts of the upper slope and the piedmont of the seamounts.

The lowermost reflection on the record was used as the acoustic basement, and the total thickness of the alternation of the acoustically transparent (blank parts on the monitor images) and opaque (colored parts on the monitor images) layers was read from the record as corresponding to the thickness of the unconsolidated sediments. And the results were expressed as isopach map of each seamount. The acoustic basement sometimes include not only the bedrock, but also the dense parts of the unconsolidated

sediments and those zones including many pebbles. Thus the unconsolidated sediments are often thicker than that indicated on the SBP records. The SBP sediment layers in this paper indicate the thickness from the seafloor to the acoustic basement.

The seamount in area MC11 is a dome-shaped guyot and unconsolidated sediments cover the whole summit and is thick in the central part. The seamount in MC12 area is an oceanic- ridge seamount and the unconsolidated sediment distribution of the summit is small while there are many exposures of acoustic basement indicating rock outcrops. On the other hand, those in MS13 and MC13 areas have many exposures at the steep slope in the central part of the summit where ridge topography and pinnacles occur, and unconsolidated sediments are distributed in gently inclined parts such as summit peripheries.

(2) Classification of SBP types

The reflection patterns of the SBP record of the four areas were classified into O-type and T-type as shown in Figure 3-3-1.

1) O-type

The SBP reflection patterns consist entirely of acoustically opaque layers.

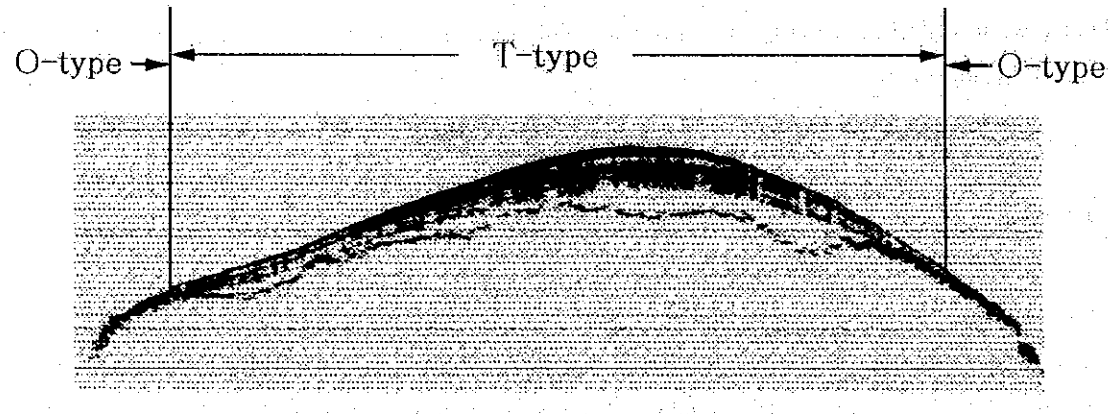


Fig. 3-3-1 Types of nSBP Record

O-type is observed in the whole seamount of pointed seamounts. It is seen from the summit peripheries to the slopes of the guyots. This type generally corresponds to rock outcrops or manganese crusts and at times to those thinly covered by sediments.

2) T-type

The SBP reflection patterns consist of alternation of acoustically transparent and opaque layers.

T-type reflection appears at guyot summits and terraces. The thickness of the alternation varies considerably from 10 to 100m. This type is considered to correspond to unconsolidated sediments.

(3) Characteristic features of individual areas

<Eastern Sea>

1) MC11 area

The SBP section and an isopach map of the summit are laid out in Figure 3-3-2(1) and 3-3-3(1).

The SBP record shows T-type from the periphery to the central part of the summit where unconsolidated sediments reach a maximum thickness of over 60m. The acoustic basement is clear and the gentle dome formed by the bedrock is observed.

O-types that show rock exposures are observed near the pinnacles in the eastern part and somewhat toward the center from the northwestern part of the summit and the isopach contours have irregular shape.

2) MS13 area

The SBP section and an isopach map of the summit are laid out in Figure 3-3-2(2) and 3-3-3(2).

The central part of the summit has large relief with many pinnacles.

Acoustic basement occur scattered on the summit and it is believed to correspond to the pinnacles . The northern summit has gentle undulating surface and unconsolidated sediments expressed by acoustically transparent layers are distributed with thickness locally exceeding 80m.

<Western Sea>

1) MC12 area

The SBP section and isopach map of the summit are laid out in Figure 3-3-2 (3) and 3-3-3 (3) .

Exposed rocks are observed on the whole summit reflecting the ridge-type topography. At the terrace showing collapsed topography on the southern side of the summit, 10m-thick acoustically transparent layers indicating sediments occur locally.

Rock outcrops occur scattered from the upper to middle slope. Sediments indicated by SBP transparent layers are thin with a maximum of about 40m. The distribution of unconsolidated

sediments tends to be fewer on the southern slope compared to that of the northern slope.

2) MC13 area

The SBP section and isopach map of the summit are laid out in Figure 3-3-2 (4) .

The summit has large relief and is generally covered by unconsolidated sediments shown by T-type with the exception of the pinnacles at the northern edge. The sediments exceed 80m at the thick parts of the summit.

3 – 4 SSS Survey

SSS survey was carried out with the major objective of clarifying the micro- topography of exposed bedrocks and the distribution of cobbles. Thus the track lines were set through the exposed bedrocks in the summit periphery, particularly the terraces.

The results show that, with the exception of the MS13 area, the seamounts of the study area have narrow terrace-like topography at the periphery of the summits and that the occurrence of cobble crusts is possible in these parts.

The results of the SSS survey in MS13 and MC13 areas are reported below. SSS survey was not carried out in the MC11 area because of the small size of the seamount and in MC12 because of the oceanic ridge topography.

<Eastern Sea>

1) MS13 area

The SSS image, MBES acoustic reflection intensity distribution, MBES bathymetric map, and the profile of seafloor topography of survey line of MS13 area are shown in Figure 3-4-1 (1).

This seamount has little unconsolidated sediment cover, and there are two rows of exposed rocks in the central part of the summit associated with pinnacles and ridge topography. Therefore the SSS track line was set for approximately 5nm across the rock exposure in order to confirm the distribution of the cobbly material and unconsolidated sediments at the saddle of the ridge. The image is generally dark with the exception of the section between 160° 36' and 160° 37' E and the zone north of 160° 37'~160° 38' E where the image is pale. It is inferred that rocks are exposed in most places of the track line. The dark image also appears widely in depressions between pinnacles, and

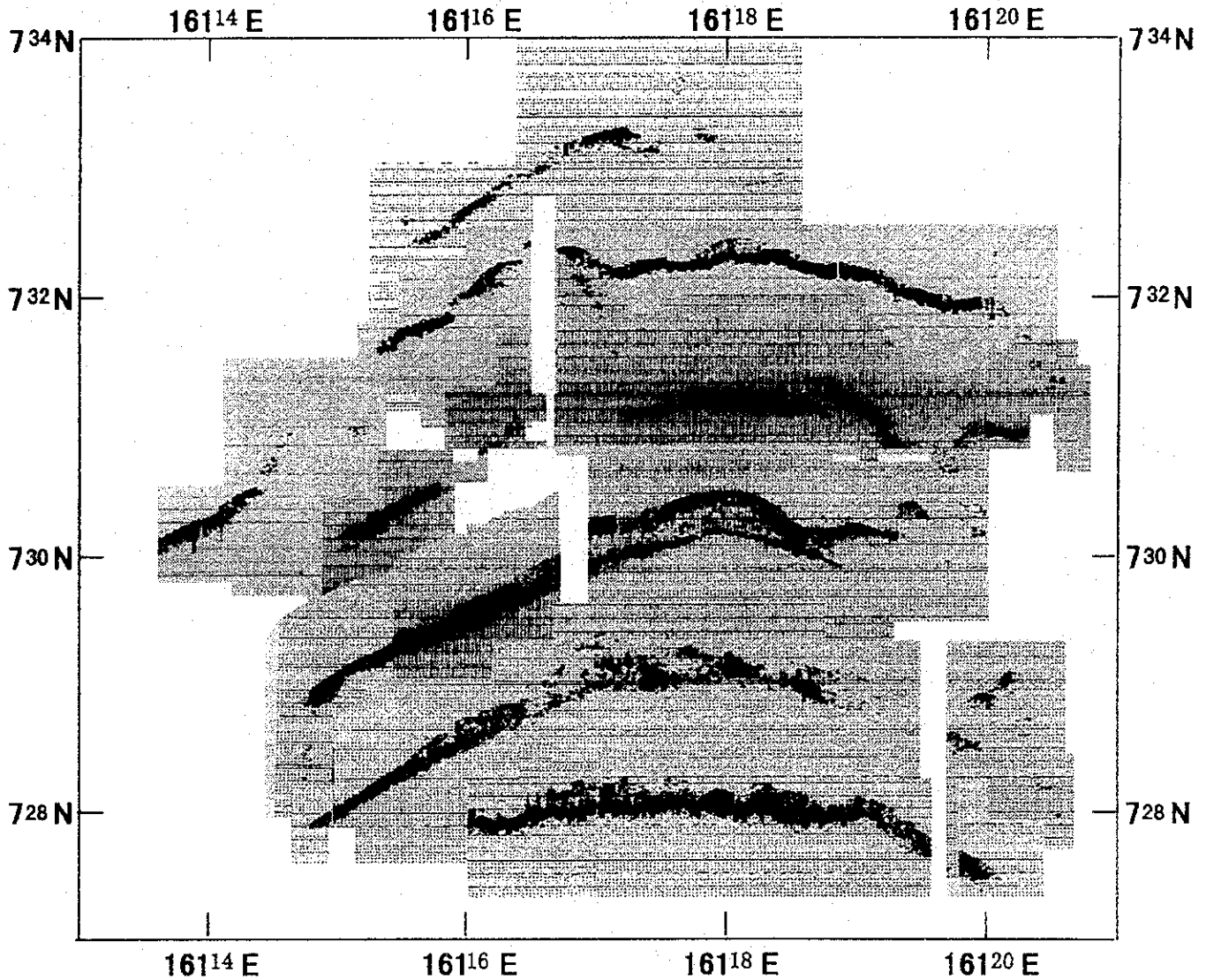


Fig. 3－3－2 (1) SBP Profiles in MC11 Area

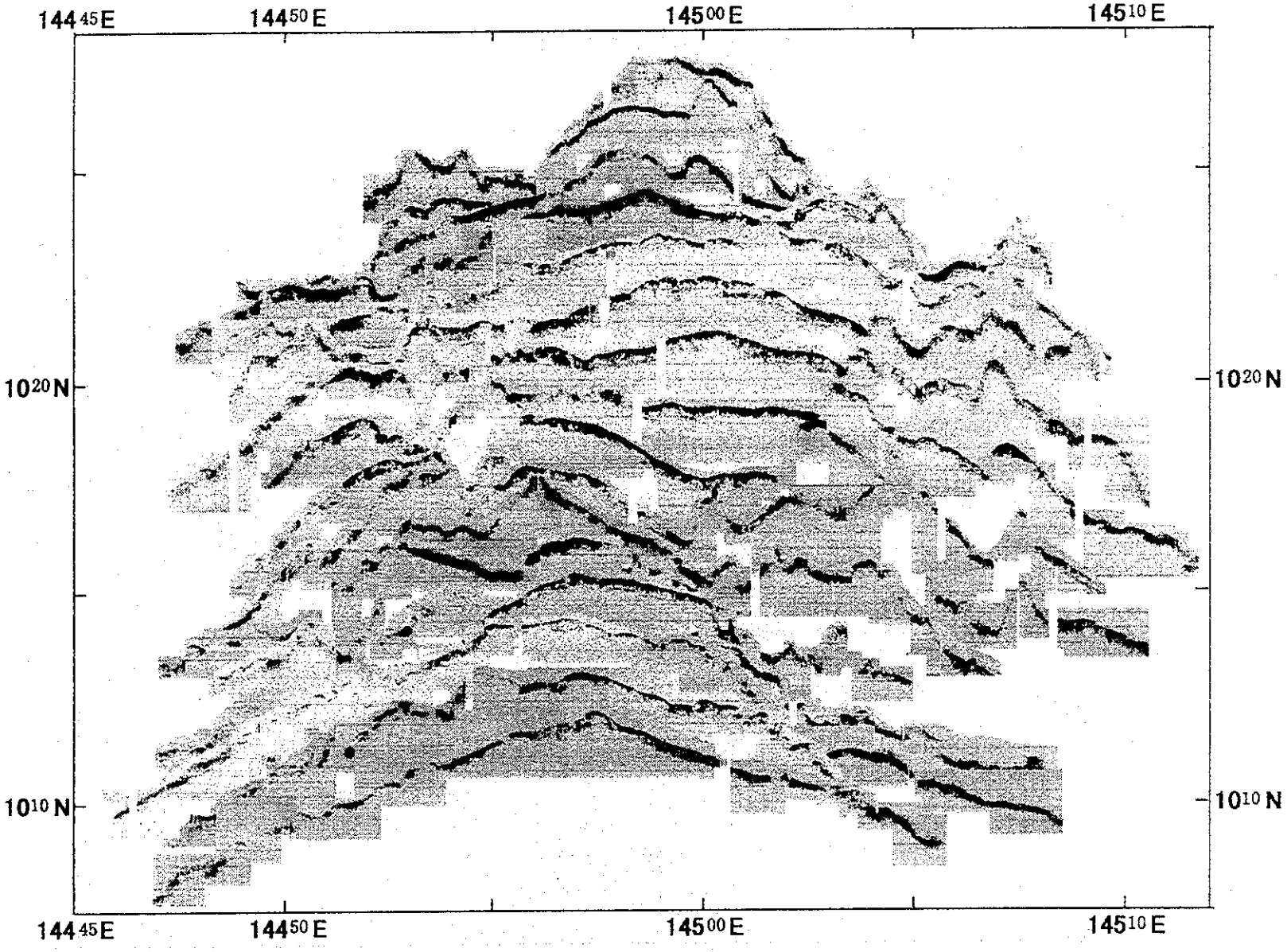


Fig. 3－3－2 (4) SBP Profiles in MC13 Area

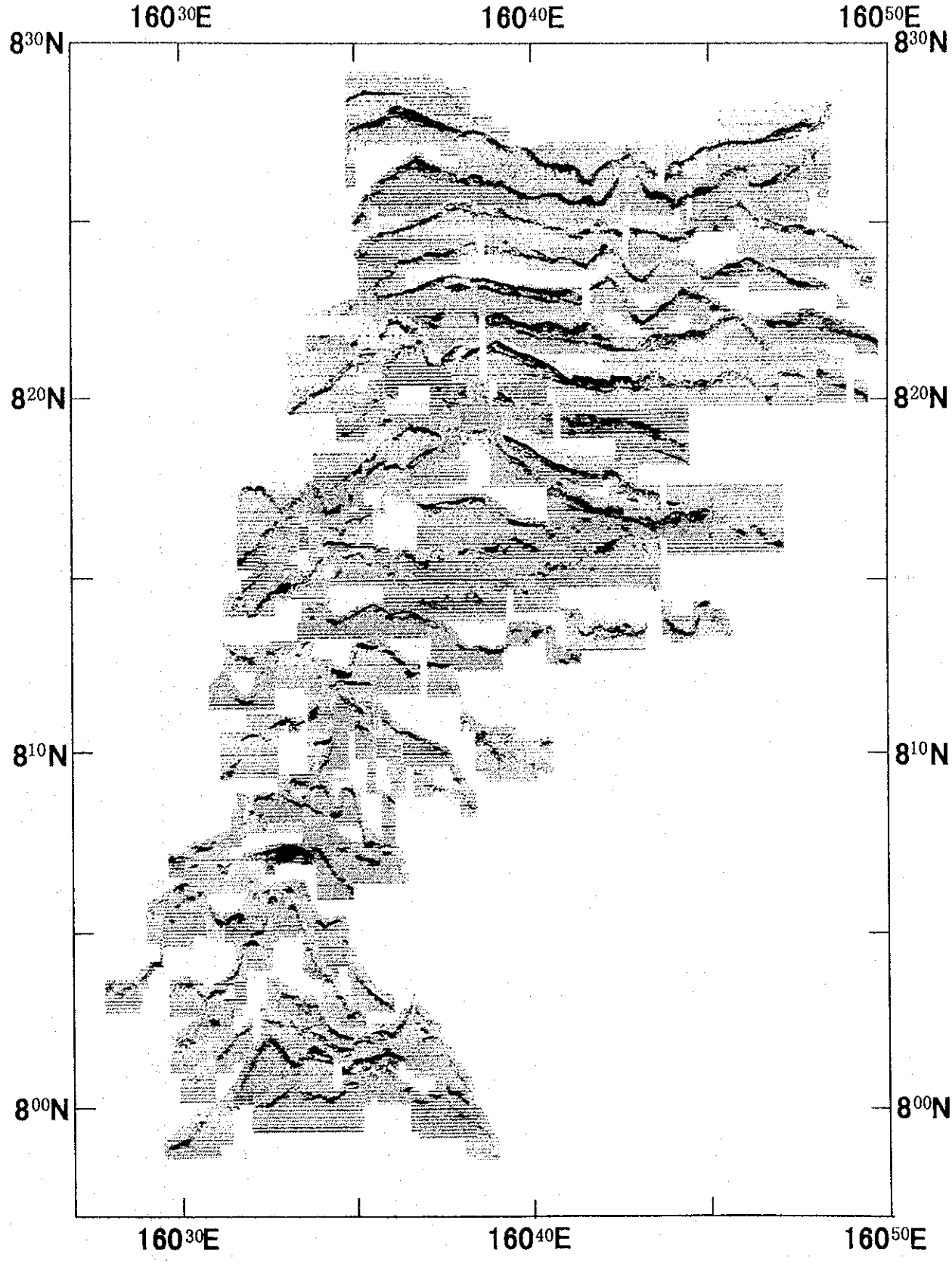


Fig. 3－3－2 (2) SBP Profiles in MS13 Area

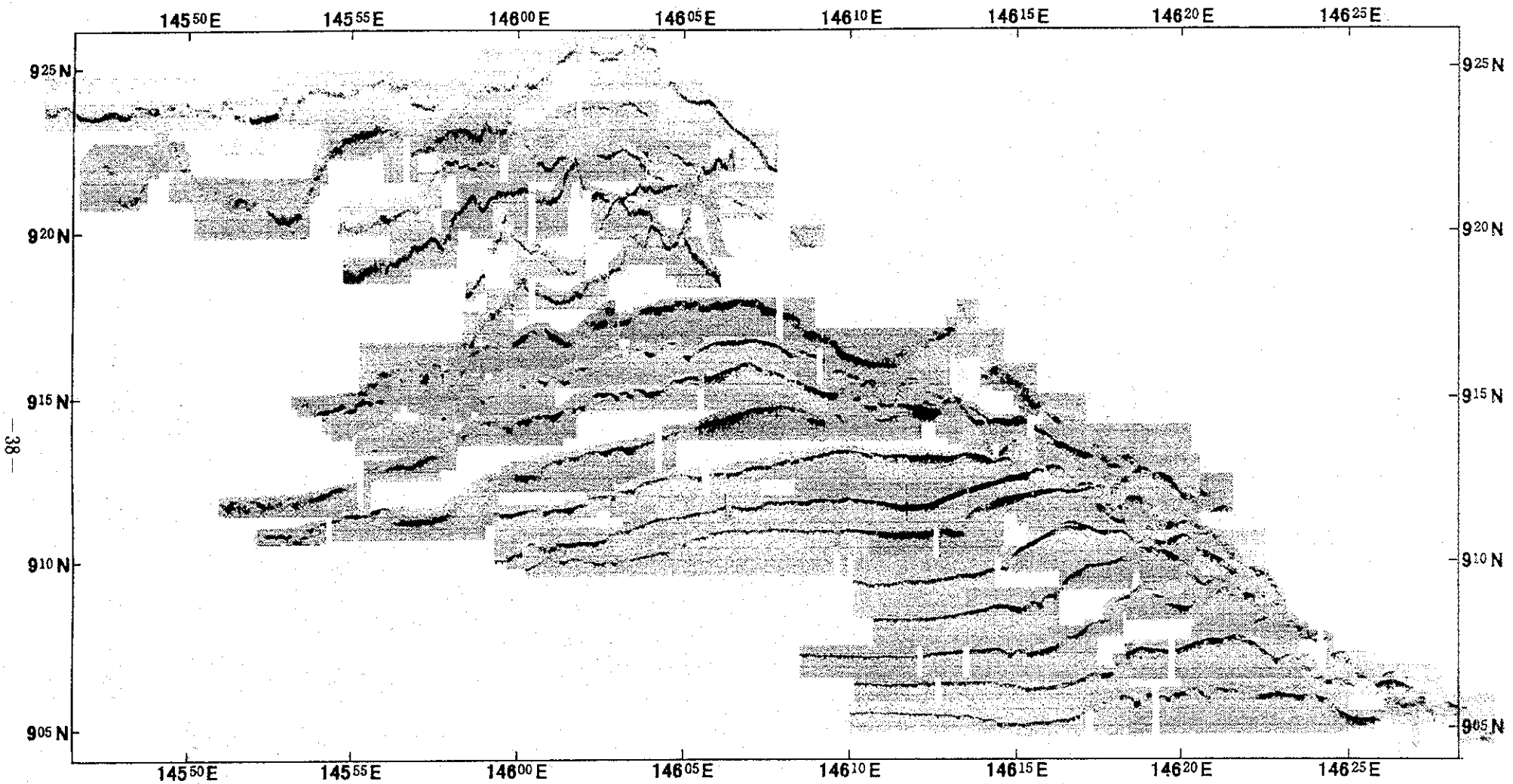


Fig. 3－3－2 (3) SBP Profiles in MC12 Area

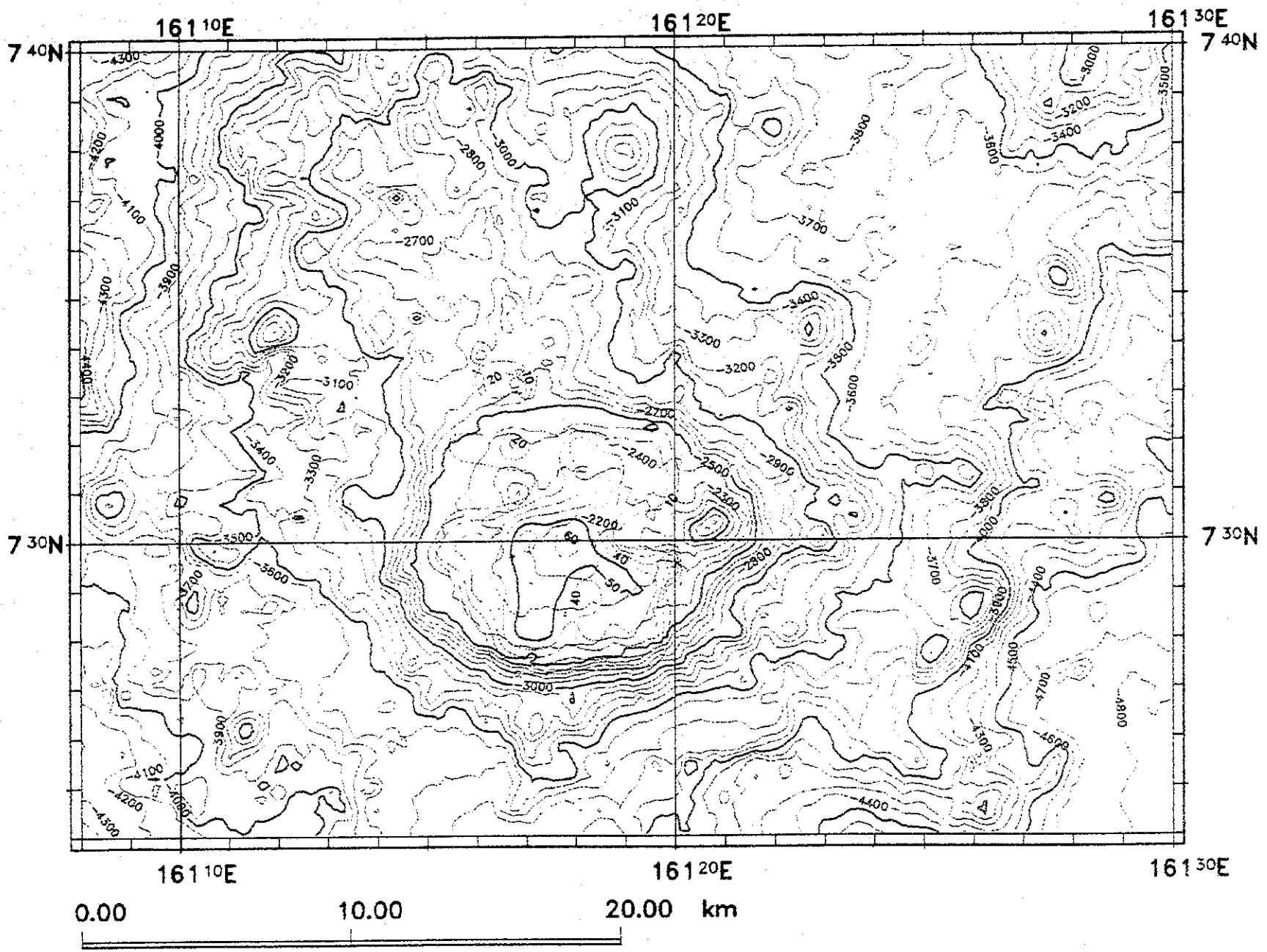


Fig.3-3-3(1) Isopach map of MC11 area.

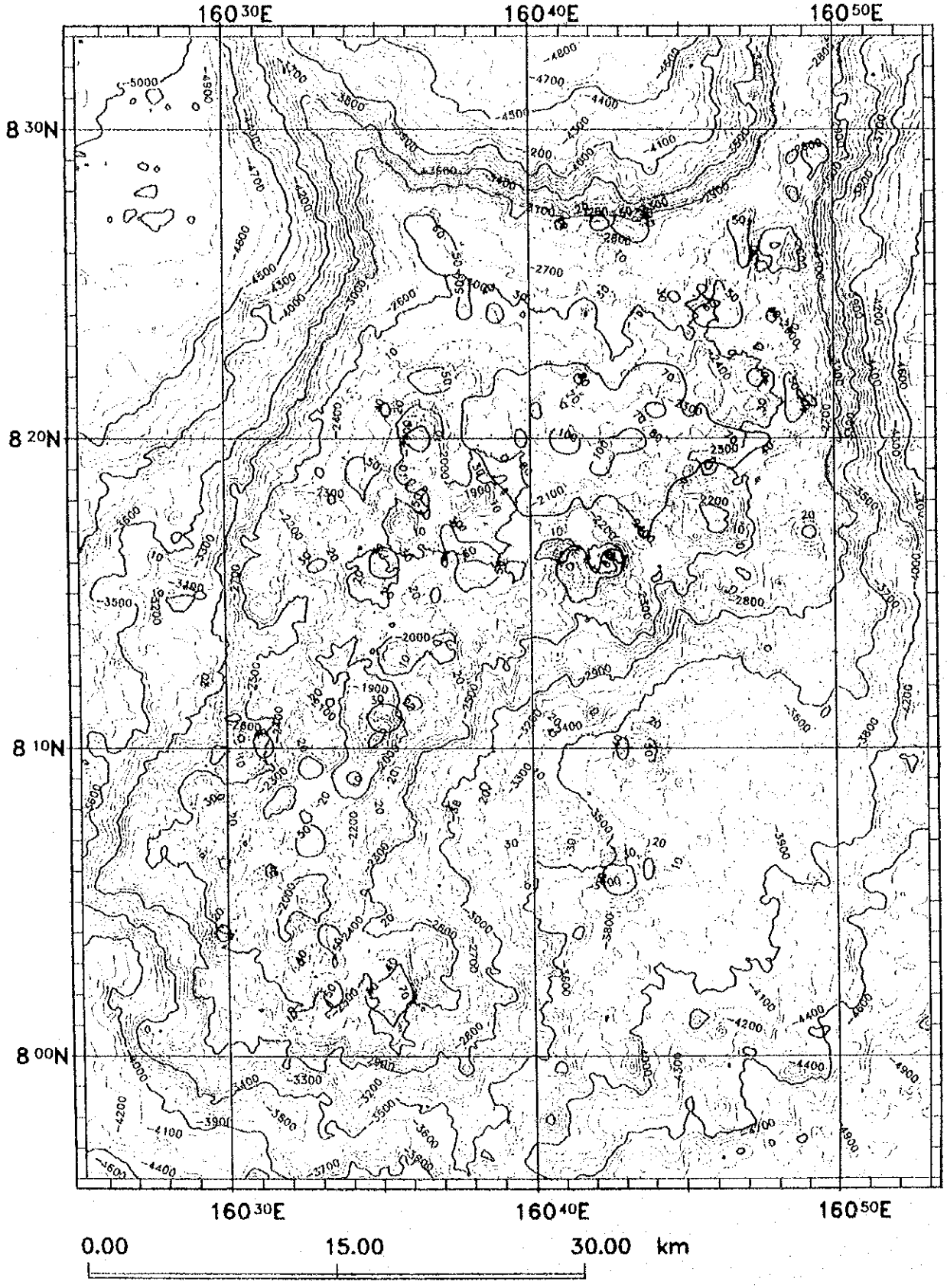


Fig.3-3-3(2) Isopach map of MS13 area.

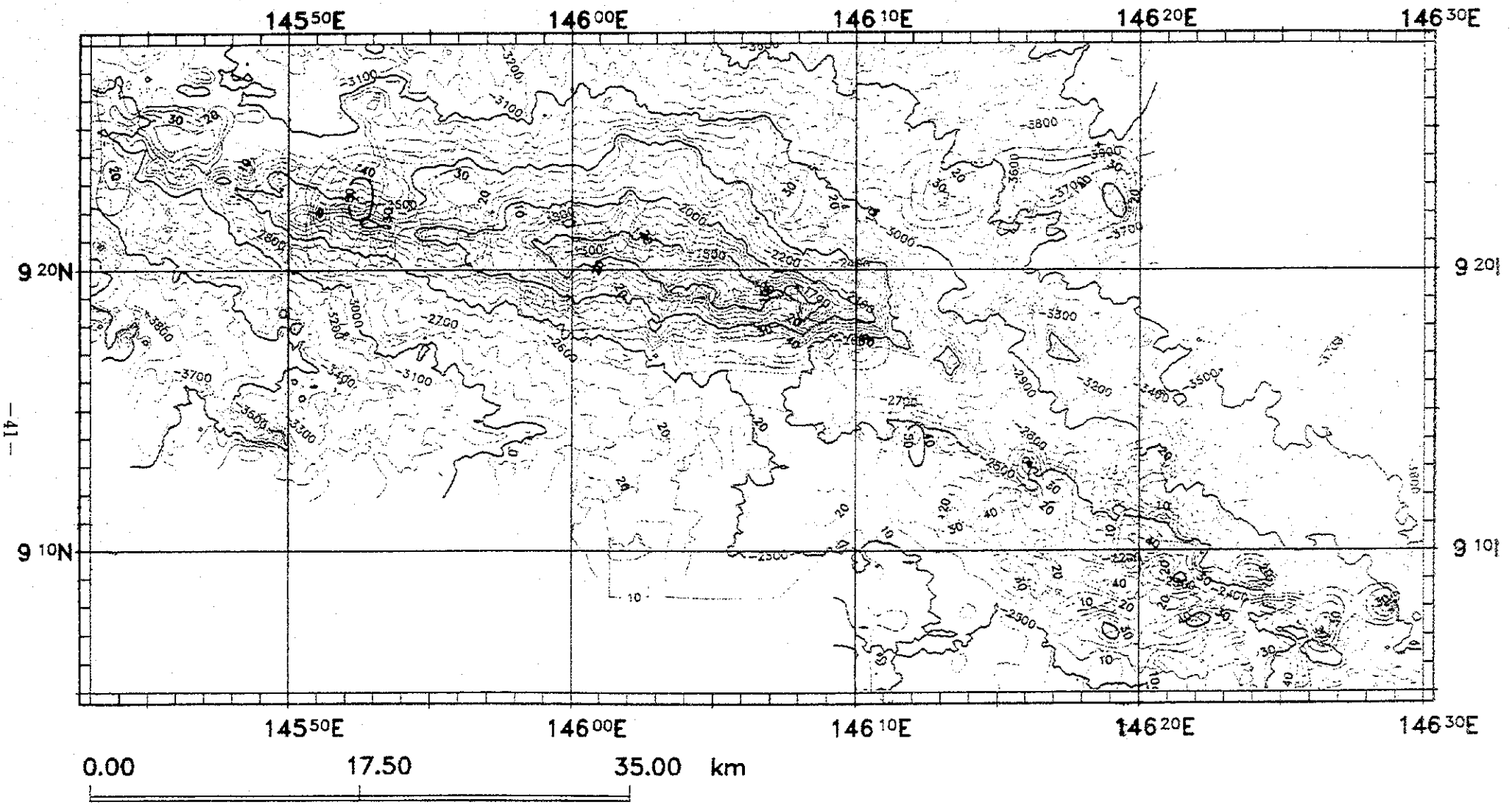
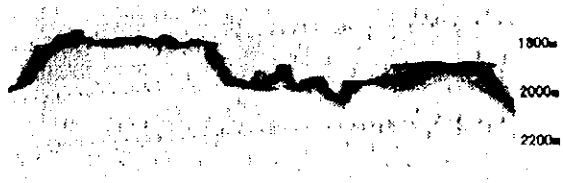
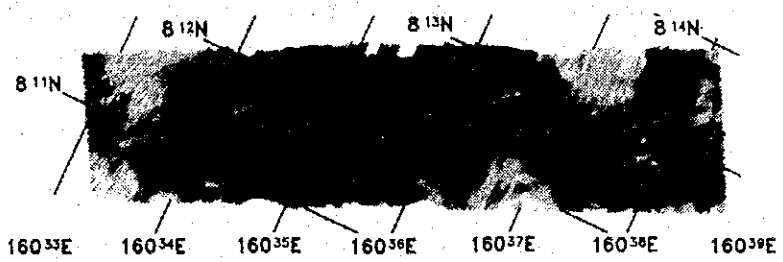


Fig.3-3-3(3) Isopach map of MC12 area.

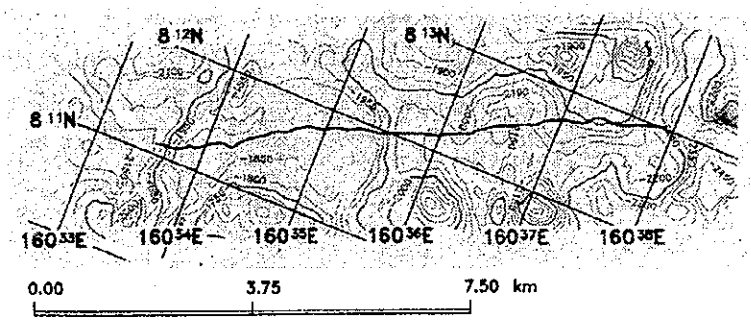
Sidescan Image



SBP profile



Acoustic reflection image based on MBES



Bathymetric map based on MBES

Fig. 3-4-1(1) Results of side scan sonar survey of MS13 area

the distribution of unconsolidated sediments appear to be very local.

<Western Sea>

2) MC13 area

The SSS image of MS11 area is shown in Figure 3-4-1 (2).

The SSS image, MBES acoustic reflection intensity distribution, MBES bathymetric map, and the profile of seafloor topography of survey line of MC13 area are shown in Figure 3-4-1 (2).

This area has a steep slope with 1,000~1,500m relative height on the northern side. This steep slope is considered to be a structural slope. The southeastern and western side consists of gentle slope. This is a plateau-type seamount with 2,200m water depth at the flat summit. The rock exposures where the crusts occur in this seamount are centered around a ridge-type high at the northern part of the summit where the water depth is 1,700m. Therefore, the SSS track line was set over the top of this high in order to confirm the conditions of the exposures, and distribution of the cobbly material and unconsolidated sediments. It was set immediately below the summit at the south side where the slope becomes a little gentle and the length was 5.4nm.

This track line begins at the flat summit on the western side, gently increasing height, passing through the saddle between two highs and ends at the ridge-type summit shoulder continuing to the upper slope of the seamount. With the exception of the pale-colored part indicating unconsolidated sediments at the terrace near 2,100m depth at the western part of the track line and the gently sloping saddle, strong reflection intensity occur indicating cobbles on the stepwise exposed rocks.

3 - 5 Distribution of Unconsolidated Sediments

The distribution of unconsolidated sediments of each area is summarized from the results of MBES acoustic intensity map, SBP and SSS survey as follows.

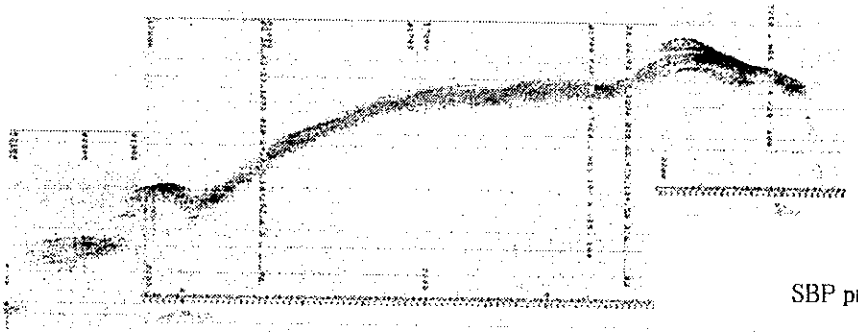
<Eastern Sea>

1) MC11 area

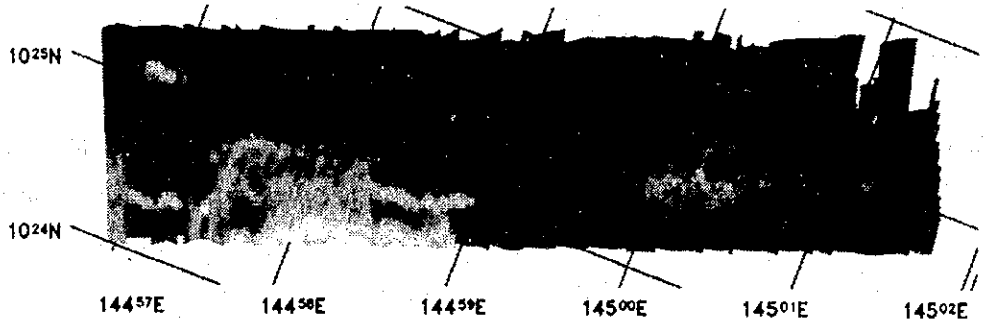
The summit of this seamount has gentle dome structure, and the unconsolidated sediments thicken from the periphery to the central part. The thickest is about 60m at the shallowest summit center. The bedrock itself has gently sloping dome structure at the summit.

The slope is generally covered by sediments although the upper eastern slope is thinly covered and

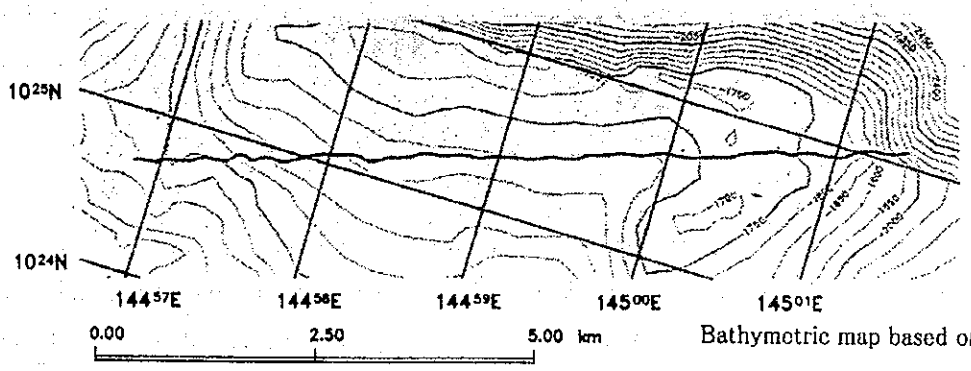
Sidescan Image



SBP profile



Acoustic reflection image based on MBES



Bathymetric map based on MBES

Fig. 3-4-1(2) Results of side scan sonar survey of MC13 area

some rocks are exposed. It is inferred that the western slope is covered by particularly thick sediments from the shoulder to the foot. The exposed rocks are observed near the pinnacles at the eastern edge and somewhat toward the center of northeastern part of the summit, and at the periphery.

The wide terrace at 2,700~2,800m water depth in the northern part is totally covered by thick unconsolidated sediments, but exposed rocks are observed sporadically on the slopes of the scattered pinnacles on the terrace.

2) MS13 area

This is a rugged guyot with many reliefs on the summit. The summit north of 8° 20' N is wholly covered by thick unconsolidated sediments. The seamount has gentle slope from the summit to the base. Exposed pinnacles are scattered to the south of 8° 20' N. The sediments in the depressions among the pinnacles are generally thin.

<Western Sea>

1) MC12 area

The summit is generally exposed with local sedimentary cover, and the thickness of the sediments is under 20m. The distribution of the sediments is somewhat wider on the northern summit slope compared to the southern summit slope.

The sediment cover on the slope is also local and generally thin above 2,500m water depth. However, relatively thick unconsolidated sediments are observed on the valleys of the southern slope. Although the thickness varies, the slope below 2,500m is generally covered by unconsolidated sediments.

2) MC13 area

The summit is widely covered by unconsolidated sediments with the exception of the ridge-type high in the northern end. The maximum thickness of the sediments attains 80m. Also the slope on the western side of the summit is gentle from the summit to the base and it is covered entirely by unconsolidated sediments. Thus the exposures with the possibility of crust occurrences are observed on the ridge-type topography on the northern part of the summit and the northern slope with steep inclination continuing from it.