

seamounts, which rise by more than 1500 m above the flat basin floor are the prominent features in the CIB. The central seamount is about 10 km wide and 30 km long at its foot and its slopes are 17°-19° steep. The minimum depth at the top of the mount is 3148 m and the total relative height of the mount is about 1550 m. The dredge samples suggest it to be a volcano (Kashintsev et al. 1987). The minimum depth presently recorded over the northeastern mount (2964 m) is 437 m higher than the value reported on the bathymetry maps. Thus, the relative total height of the mount is 1650 m and its base is found to be more than 2 km deep under sedimentary cover (Levchenko et al. 1990; Levchenko, 1992).

The major part of the polygon M31-VI comprises of an abyssal plain, with its depth increasing gradually southwards from 4560 up to 4650 m. An erosional turbidite channel is identified in the central part of the area. In the north, the valley, has a NW-SE trend and near the foot of the central seamount it turns into N-S direction. The valley 80-90 m deep and 1.5-2 km wide, resembles a mini canyon (Evsykov, 1990).

BATHYMETRY INVESTIGATIONS IN THE S22 CRUISE

Polygon S22-I

In 1989, detailed bathymetry investigations were carried out in a 11x90 km rectangular block centered around 2°S and 81.5°E, named as polygon S22-I (Fig. 3.1). The orthogonal bathymetry tracks of 35 to 110 km length spaced at 5-10 km were supplemented with some additional lines, and the total coverage of the bathymetry in the area is about 1600 line km.

From these investigations it is clear that the polygon S22-I is characterized by very rough seafloor with depths varying from 4950 to 4347 m (Fig. 3.5), which is unusual for ocean basins. This anomaly is further peculiar because of the fact that this area is located in the distal part of the Bengal Fan where sediments are not thick enough to obscure the original roughness of the oceanic crustal surface (Moore et al. 1974).

The seafloor profiles and the detailed bathymetry map of the polygon (Fig. 3.5) are the basis for preparing the detailed geomorphology map (Fig. 3.6). It clearly shows that the study area is composed of three distinct geomorphological features: an abyssal plain in the northwest where the bottom depth varies from 4770 to 4827 m (4800 m is the average) and two rises in the northeast and in the southwest, which are 630 and 450 m high, respectively.

The northeastern rise is represented by a series of E-W trending elongated hills of 9-22 km length and 40 to 150 m height. Approximately in the central part of the rise an elongated hill of 43 km long and up to 350 m high is observed. All the elongated hills have distinct asymmetric contours with steeper southern slopes (Fig. 3.5). A comparatively large block of a

complex structure is located in the southern portion of the rise. Its flat northward tilted top of 8 km wide consists of small hills. In the south, the block is terminated by a scarp, 15°-17° slope and almost 600 m high. This scarp is due to a near E-W trending local fracture.

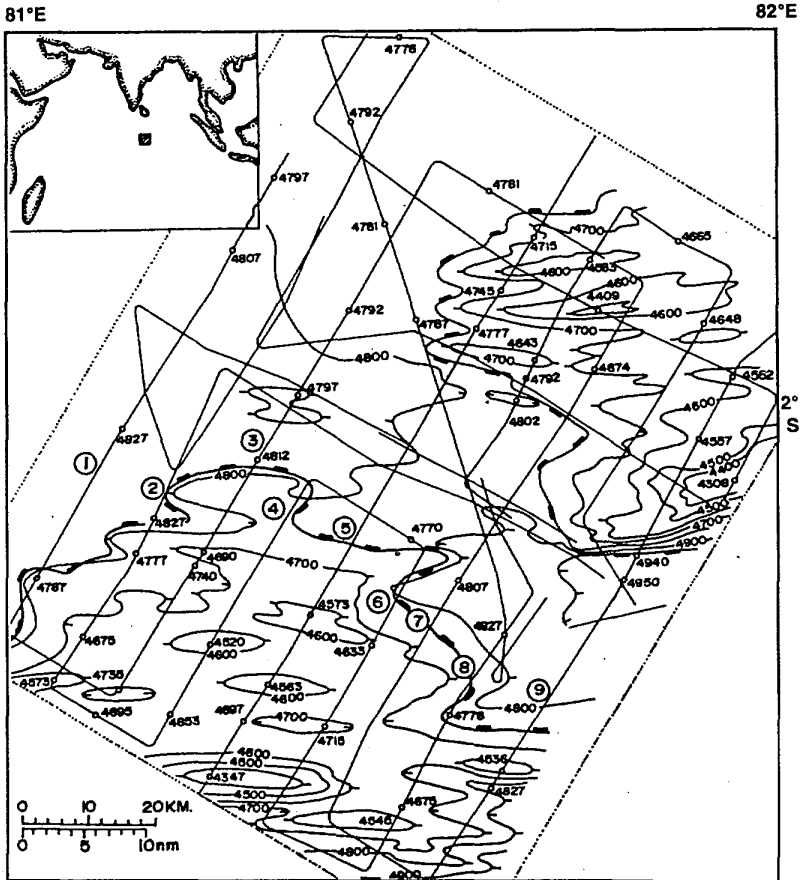


Fig. 3.5. The bathymetry map of the S22-I area. dotted line - boundary of the S22-I area; continuous line with nos. - isobaths, m; continuous line with thick rectangle blocks - foot of the swell. Inset shows location of the the area.

The southwestern rise is similar to the above described one. It is also associated with a series of E-W trending asymmetric hills. In the northern flank of the rise a small hill of 7-9 km long and 70-100 m high occur. Towards the center these hills increase up to 25-40 km length and 250-350 m height. Almost all the hills have steep (7°-9°), southern slopes and gentle (2°-4°) northern slopes.

Small elongated hills of 15-20 m high with gentle slopes occur between the two rises within a smooth bottom, more than 45 km wide. According to the single-channel seismic reflection data, they are the crests of large sedimentary folds obscured by undeformed flat-lying sediments (Levchenko and Evsykov, 1992). The abyssal plain in the northwestern part of the polygon is traversed by the turbidite current channel of 25-40 m deep (Fig. 3.6).

Since the main objective of the study in this area was to determine the crustal structure by means of seismic refraction studies, the morphology of the two main rises could not be completely defined. It is only possible to suggest that they are as prominent as the rises that were studied in detail by

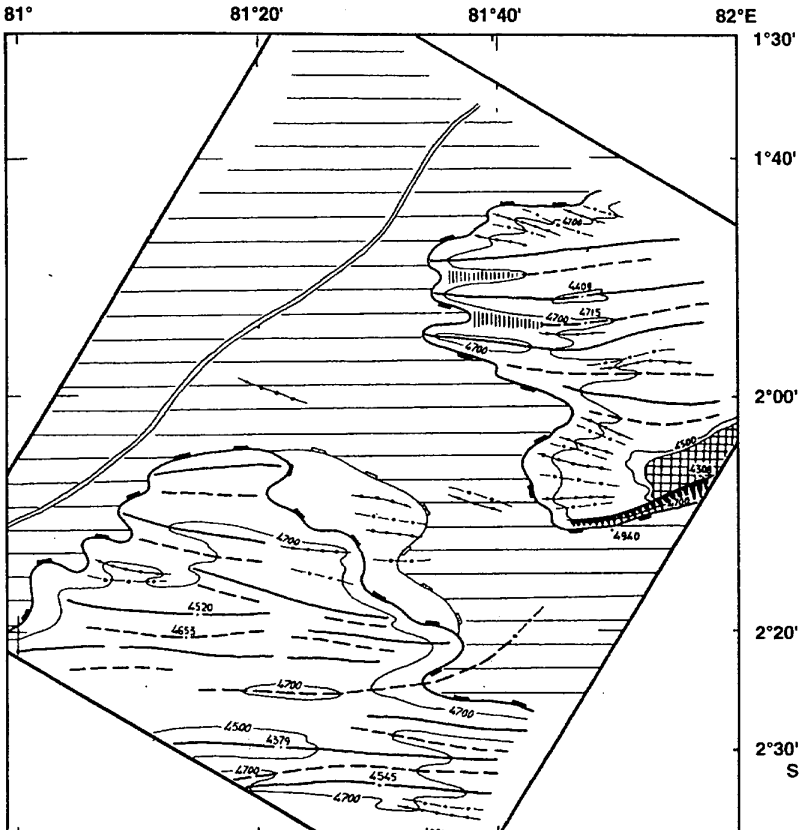


Fig. 3.6. The geomorphology map of the S22-I area. continuous line with rectangle blocks - foot of swell; hatched in grid - flat bottomed block; sawtooth markings - steep scarp; continuous line - axis of rises; dash line - axis of depression; line with solid circle - axis of smaller rises; line with open circle - axis of smaller depression; vertical hatches - flat bottom of valley; line with open rectangular blocks - edge (eyebrow) of hummocky terrace; continuous stripples - flat bottom of basin; continuous double line - turbidity current channel; continuous line with nos. - isobath, m; dot with nos. - point depth, m.

Evsykov (1986, 1990, 1991). The geomorphology and bathymetry maps and sections distinctly show morphological heterogeneity and contrasting character of the bottom topography of these features. They suggest that the features evolved during a long geological time, perhaps divided into some stages, and seem to have been affected by repeated compression with changes in the direction of stress.

Polygon S22-II

This forms the main area of detailed bathymetry survey carried out during the 22nd cruise of the R/V Professor Shtokman (Fig. 3.1). It is a 220 x 440 km rectangular block extending in a NE to SW direction centered around 0°N and 83°E. The orthogonal bathymetry lines with 35 to 440 km length were spaced at 15 to 35 km. Their total length is about 7450 line km.

The detailed bathymetry map of the area constructed from bathymetry data (Fig. 3.7) and a set of seafloor profiles (Fig. 3.8) provide a detailed morphology of three rises, which mainly extend in a SW-NE direction. This map also shows a turbidite channel, 50-70 m deep off the eastern slope of the rises at 5-10 km distance from the foot of the northern one.

The southwestern rise (around 0°45'S and 81°50'E) at the polygon is about 20 x 30 km in lateral size. It is formed by three E-W trending hills of 15-30 km long and 120-250 m high (Fig. 3.7). The minimum depth on the largest hill (340 m high) is 4358 m and the depth of the flat bottom near the southern foot of the rise is 4700 m. The average depth of the sea floor is 30-50m deeper than near the northern foot of the rise. Mapping of the elongated hills is difficult in this area because the rise is covered by only two bathymetry lines (Fig. 3.8c). The morphology and strike of the hills are extrapolated from other swells studied in detail in the southwestern part of the area.

The central rise in the polygon extends in a SW-NE direction (Fig. 3.7) and is about 70x105 km in lateral size at its base. The minimum depth on the rise is 3912 m and its southwestern base is surrounded by flat bottom surface at a depth of 4668 m. Total height of this rise is 726 m. This feature like the other rises is associated with a number of gentle folds, manifesting themselves in the seafloor as elongated hills. The rises and adjacent depressions are from 10-20 m to 40-60 m high. It is interesting to note that the rises and depressions are observed both in NE-SW profiles and in NW-SE profiles (Fig. 3.8b).

The NW-SE bathymetry profiles show similarity of the central rise with one-sided horst with a steep (6-8°) southeastern slope and a gentle (1.5-2°) northwestern slope (Fig. 3.8b, lines 1, 2, 14). The southern foot of the rise is formed by some E-W trending elongated hills of about 15-20 km long and up to 270 m high. In general, the central rise is morphologically similar to the rise in the polygon M31-V.

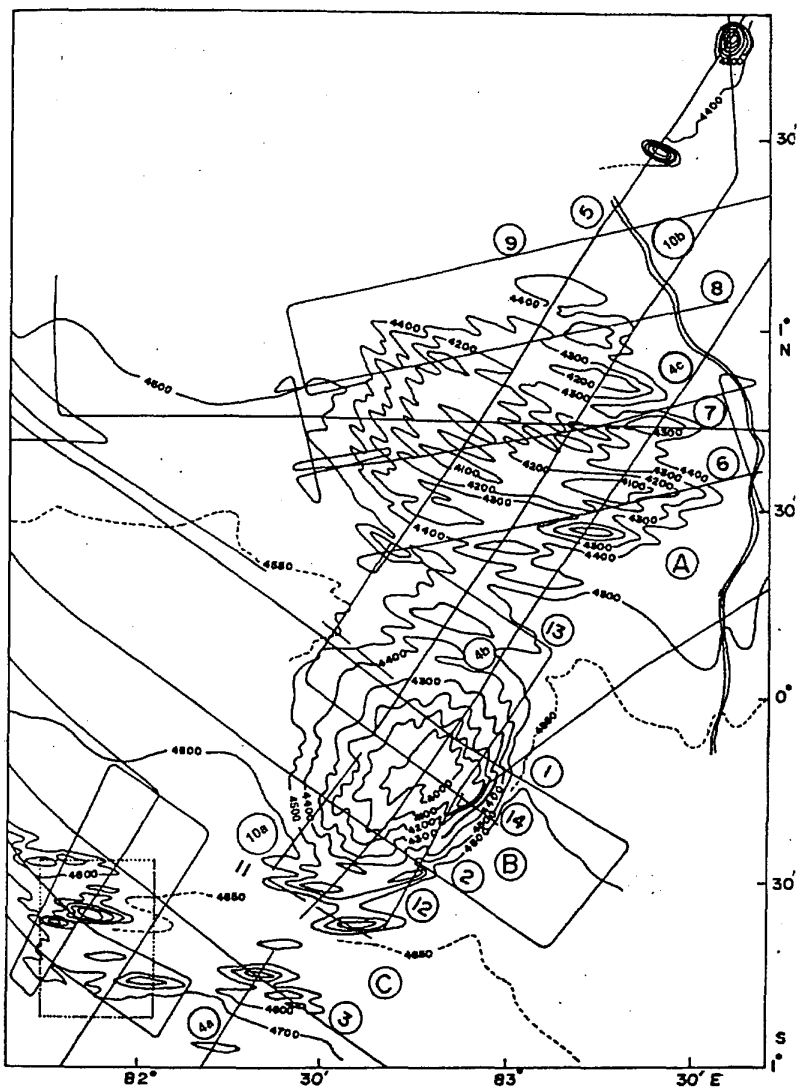


Fig. 3.7. The bathymetry map of the S22-II area. thick continuous line - bathymetry profiles shown in Fig. 3.8; line with no. - isobath, m; double lines - turbidity current channel. Dotted box shows location of the R/V Vityaz detailed survey area.

The northeastern rise is the most conspicuous one in the polygon S22-II (Figs. 3.7 and 3.8). Its base is about 100 x 135 km in lateral size. A minimum depth of 4041 m is recorded in the south eastern part of this rise. Its southern edge is surrounded by flat bottom at a depth of 4530 m. The total height of the rise is about 485 m.

60-80 m and at some places even up to 120 m. The southern slope of the rise is formed by four elongated hills 45-55 km long and 200-300 m high (Fig. 3.8, lines 4c, 10b), all being asymmetric.

The trends of the elongated hills change from NNW-SSE in the north-western part to near E-W in the south-east (Fig. 3.7). The tops of these hills are generally smooth with exception at some places (Fig. 3.8a, lines 7, 8).

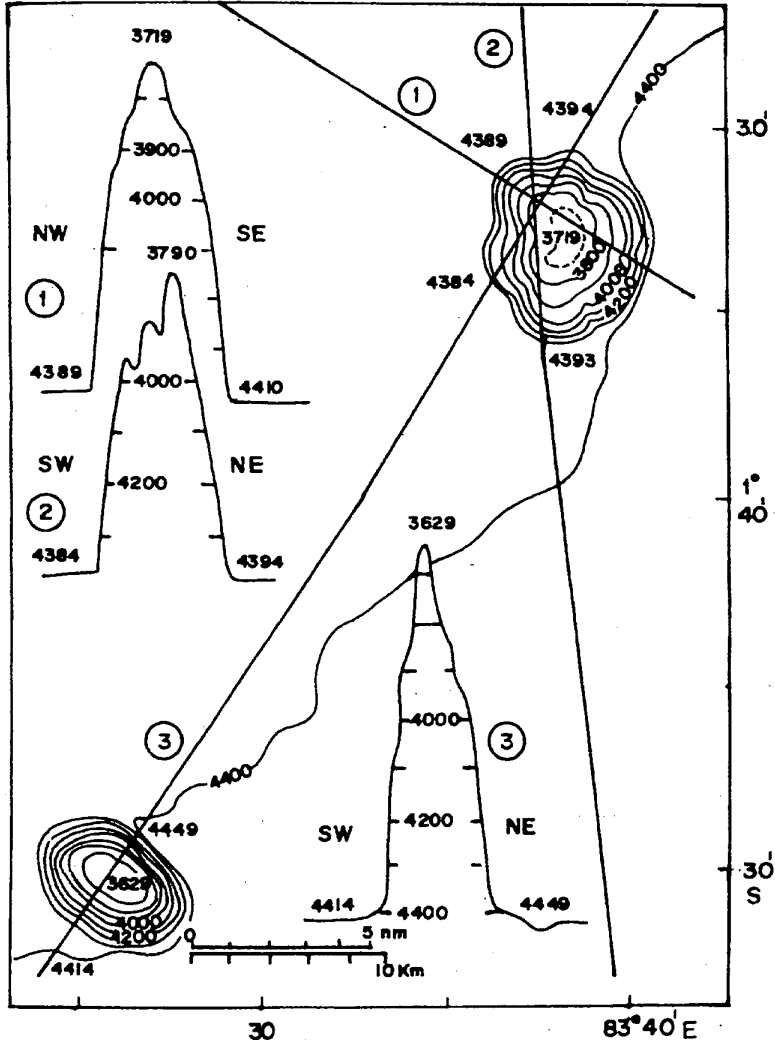


Fig. 3.9. The bathymetry of the 3719 m seamount and 3629 m seamount in the northeastern part of the S22-II area. 1 and 2 are the cross-sections of seamount 3719 and 3 is cross-section of seamount 3629.

In the Geological-Geophysical Atlas of the Indian Ocean (1975) a bathymetry map of small area is shown, which was constructed from the data of the R/V Vityaz cruise (Fig. 3.1). A bathymetry survey of 130 km long was carried out in the same area during the 22nd cruise of the R/V Professor Shtokman (Fig. 3.8). A new bathymetry map near the R/V Vityaz survey area was now constructed on the basis of the geomorphology observed from the M31-V and S22-I data. Orientation of the relatively large hills near the Vityaz area was corrected and they seem to extend most likely in a E-W direction than NW-SE. About six large hills of 6-8 to 15 km length and 40-70 to 400 m high are present. They are asymmetric, similar to those observed in the S22-I area, i.e. with a steep southern slope and a gentle northern slope. The flat bottom surface near the base at the southern end is 20-30 m deeper than it is at the base of the northern end. Thus, the hills near the Vityaz area act as barriers for sediment distribution southward similar to other E-W features within the intraplate deformation area in CIB.

The regional bathymetry investigations recorded a number of seamounts in CIB. Many geophysical lines in the 22nd cruise of the R/V Professor Shtokman were extended beyond rises to delineate the buried parts of the features from seismic reflection data. Two hitherto unknown seamounts were revealed in some of these profiles in the northern portion of the S22-II area where the seafloor is otherwise flat (Fig. 3.9). The northeastern seamount in this area was traversed thrice, while the other southwestern one once (Fig. 3.9). They were named as "the 3719 seamount" and "the 3629 seamount", respectively, indicating the minimum depth recorded on top of the seamounts.

The 3719 seamount near its base is 7 x 9 km in areal extent. Its slope has a step-like appearance and shows signs of small valleys similar to barrancos of continental volcanoes. The slopes are 12°-15° steep. Top of the seamount seems to be associated with elongated hills. The relative height of the 3719 seamount is 675 m.

The 3629 m seamount is about 5 km wide near its foot. Its step-like slopes are 16°-18° steep. The maximum depth near its foot is 4449 m. This seamount is 820 m high.

Seismic reflections could be obtained on the seamounts up to 1 km below sea bottom. It is possible to suggest on the basis of the morphology that they are volcanoes formed during some stages of intraplate volcanism. In general, the new seafloor map and the bathymetry profiles from the S22-II area revealed clearly the morphology of seamounts/rises within the hitherto poorly studied part of the intraplate deformation area of the CIB. The features are characterized by different lateral sizes, heights and elongated hills of different strike. On the basis of the available geological and geophysical information, it is possible to suggest that a regional NW-SE trending fault along which a major compressional stress and volcanism occurs, is responsible for the origin of these rises.

Polygon S22-III

It lies within the S22-II area and was selected for detailed seismic tomography experiment (Fig.3.1). Bathymetry investigations totaling 1110 line km were carried out in it along a grid of orthogonal lines which are 35-50 km long and are spaced 3-5 km apart. Bathymetry map of polygon S22-III is shown in Fig. 3.10.

The asymmetric range in the eastern part of the area is the most impressive feature. The seafloor relief is 23 m and 42 m along its northern and southern slopes respectively. The morphology reflects that the range is a barrier for southward distribution of the turbidites. It is possible to suggest that the S22-III investigations recorded only the western flank of the range which seems to be part of a large deformed feature.

The major portion of the polygon is characterized by flat bottom surface. Small elongated hills up to 10 m high characterized by gentle slope and SW-NE trend are recorded. The wide depression located between these hills seems to be a remanent of ancient turbidite channel. Its configuration suggests the presence of a deformed block, resulting in change in the direction of the channel to southwest.

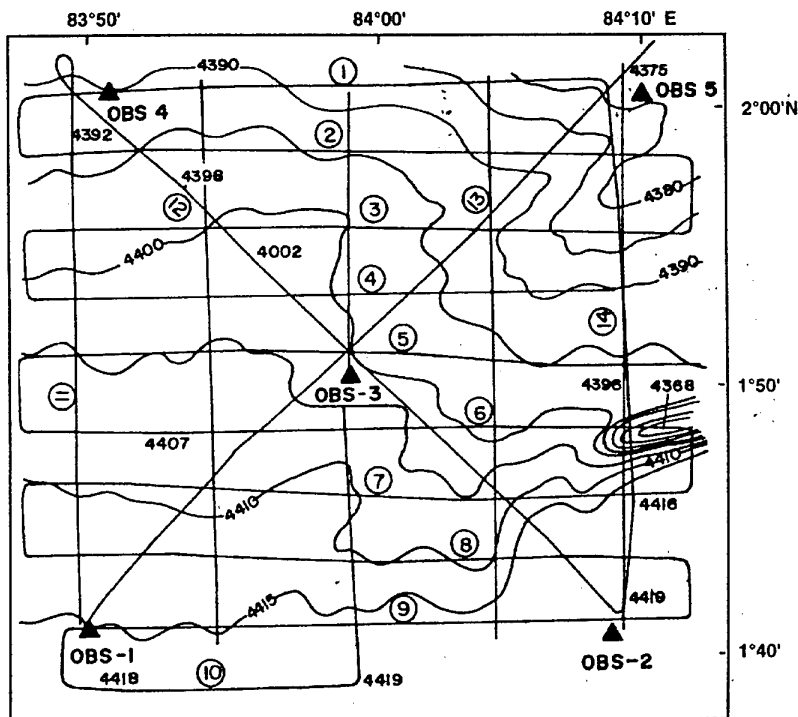


Fig. 3.10. Bathymetry map of the small S22-III area. continuous line with no. - isobath, m; solid triangle - OBS location.