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DETAILED BATHYMETRIC SURVEYS IN THE CENTRAL INDIAN BASIN

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Abstract

Over 420,000 line kilometers of echo-sounding data was collected in the Central Indian Basin. This data was digitized, merged with navigation data and a detailed bathymetric map of the Basin was prepared. The Basin can be broadly classified into three regions as high relief area, medium relief area and plain area represented by western, eastern and central portions of the Basin, respectively. The bathymetric map prepared from this survey is the first of its kind for this region and will in the future be used as a base by navigators and researchers.

INTRODUCTION

The Indian Ocean is considered to be the most complex of the three major oceans. It has many features which are unique (like the Ninety East Ridge) and many other physiographic features found in other oceans. The International Indian Ocean Expedition (IIOE, 1959-66) enhanced the knowledge of the Indian Ocean considerably. The first general atlas of geology and geophysics of the Indian Ocean was based on these studies (UDINTSEV, 1975). However, no detailed bathymetric surveys are reported from the Central Indian Basin. Though, the continental margins of India have been extensively covered by geological and geophysical surveys (SIDDIQUIE et al., 1987), other parts of the Indian Ocean have not been surveyed extensively. The Central Indian Basin (CIB) is situated between the Chagos-Laccadive Plateau and the Ninety East Ridge. This Basin is reported to contain economically exploitable manganese nodule deposits and a detailed bathymetric picture of the Basin is essential for the exploration of nodules. The National Institute of Oceanography (NIO) embarked on a detailed exploration for manganese nodules in

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the CIB in 1981 and, as a part of this program detailed bathymetric surveys in this area were carried out. Results of these surveys are presented in this paper.

DATA ACQUISITION

Over 420,000 line kilometers of echo-sounding data was collected during the period 1981 to 1990. For this purpose the services of two research vessels from India namely ORV SAGARKANYA and RV GAVESHANI and four chartered vessels MV FARNELLA, MV SKANDI SURVEYOR, MV GA REAY and DSV NAND RACHIT were utilized. Data collected from each of the ships and the equipment used for the surveys is shown in Table I. During the first phase of the surveys, the data was collected along lines spaced 60 nautical miles apart. Later, the line spacing was narrowed down to 30 nautical miles and 15 nautical miles in some parts of the Basin. The central part of the CIB has been covered by 15 nautical mile spaced lines whereas the rest of the Basin has been surveyed in a grid of 30 nautical miles spacing. Figure 1 shows the survey tracks in the CIB. As seen in Table I, different echo-sounding instruments were used on different ships. On ORV SAGARKANYA, narrow beam echo-sounding by Honeywell Elac echosounder was carried out while on the other vessels 3.5 and 12 KHz Raytheon echosounders were employed.

For Navigation, Magnavox dual channel satellite navigation system was used on all the vessels except on ORV SAGARKANYA which has the facility of an Integrated Navigation System (INS).

Table I

Table showing amount of data collected on different ships

Sr. No.	Name of ship	No. of cruises	No. of shipdays	Equipment used	Line kilometer data collected
1	RV GAVESHANI	8	164	Simrad ES	40,242
2	MV FARNELLA	8	363	Raytheon ES (3.5 and 12 KHz)	100,954
3	MV SKANDI SURVEYOR	17	720	"	116,559
4	MV GA REAY	3	135	"	31,840
5	MV NAND RACHIT	4	135	"	35,000
6	ORV SAGARKANYA	8	330	Honeywell Elac Narrow beam and Deep sea sounders	99,499
Total	6 ships	48	1,847	---	424,094

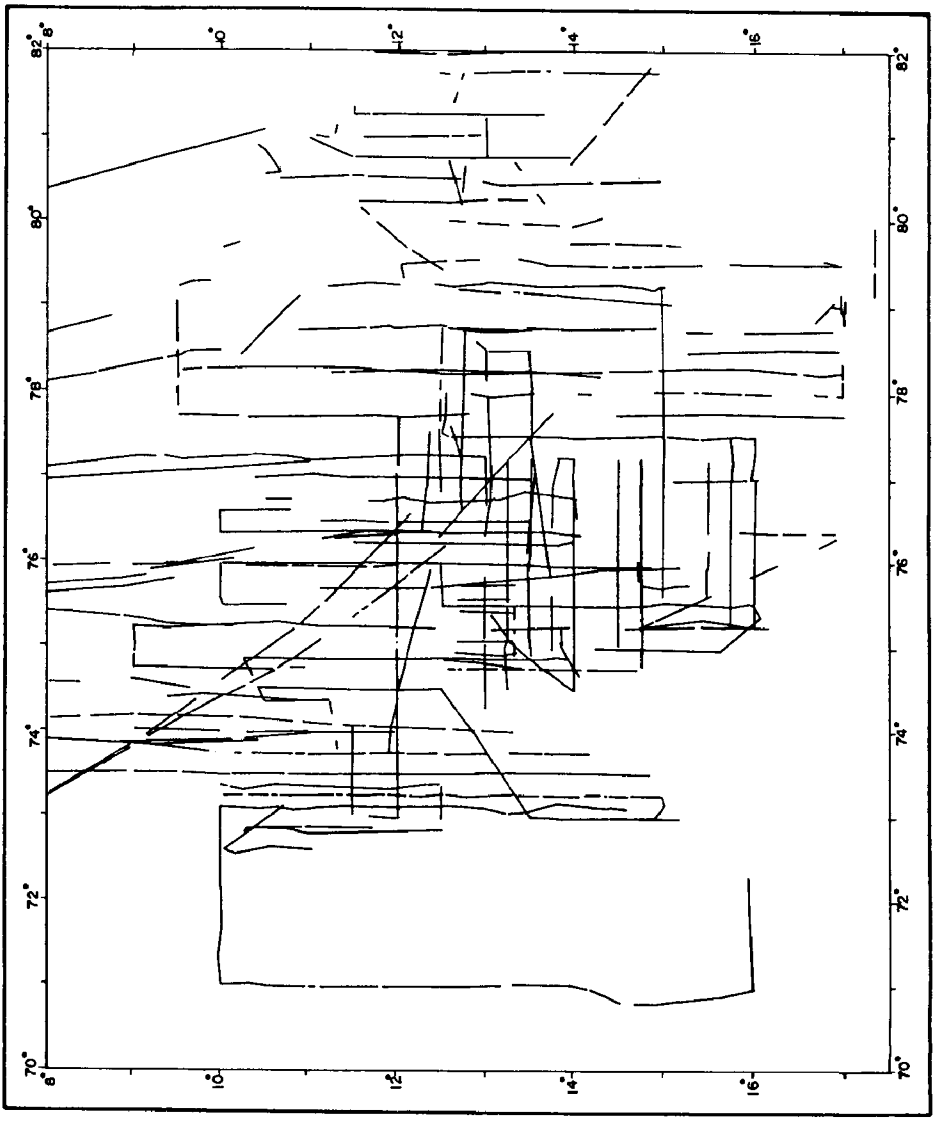

FIG. 1.- Map showing the echosounding tracks in the Central Indian Basin.

DATA PROCESSING

Large amount of the data processing was carried out on the UNIVAC 1100/60 computer system at MECON (Metallurgical and Engineering Consultants Ranchi, India). Figure 2 shows the flow chart of data preparation and the processing modules employed. For postprocessing the data, only good fix data was used and the position between two good satellite passes was interpolated. A navigation data file for every one minute time-position was created. The voluminous analog echo-sounding data was digitized using the digitizer. From digitized depth values, a one minute interval depth data file was created by interpolating depth values between two digitized depth values. Underway (depth) data and navigation data were merged to create position-depth files. Transducer and Matthews corrections (CARTER, 1980) were applied to the depth values. The merged and corrected position-depth files were generated for the different cruises. These merged files were used for generating track plots, cross section profiles and annotated underway data plots on user specified map projections.

A hand drawn depth contour map of the CIB was prepared using the annotated depth data plots (Fig.3 contour interval 100 m.). Numerous bathymetric features previously not reported may be observed on this map. However, the hand drawn depth contour map of such a huge area may be less accurate. The annotated depth data plot itself has limitations as all depth points cannot be transferred on to a map. Alternatively the GMS (GEBCO mapping system) software has been used on the ND 570 computer at NIO, using the merged position-depth data files from all the 48 cruises as input, to generate a detailed and more accurate 100m interval depth contour map (Fig.4). This map is the only one of its kind for the CIB, as no detailed bathymetric surveys of this order have been carried out in this region so far.

RESULTS AND DISCUSSION

It is observed that the average depth in the Basin is around 5,100 m, which increases from west to east. The basin, on the basis of relief can be classified into three physiographic types, as plain, rugged or high relief and medium relief areas. Broadly, the western part of the Basin from 71°E to 74°E can be classified as rugged or high relief area. In this region the depths are in the range of 2,900 to 5,000 m. The eastern part of the Basin (between 79°E to 82°E) is the medium relief area and has slightly higher depths in the range 5,000-55,00 m. The central part of the Basin (between 10°S-14°S and 74°E-76°E) is almost a plain area. There are few seamounts present in this plain region. The southern part of the Basin (south of 15°S latitude) is again a medium relief area.

Morphometric studies have been carried out on a part of the Basin and it is observed that over 90% of the area has slope angles in the range of 0-3° (KODAGALI, 1989a). The presence of numerous seamounts and abyssal hills in the Basin is

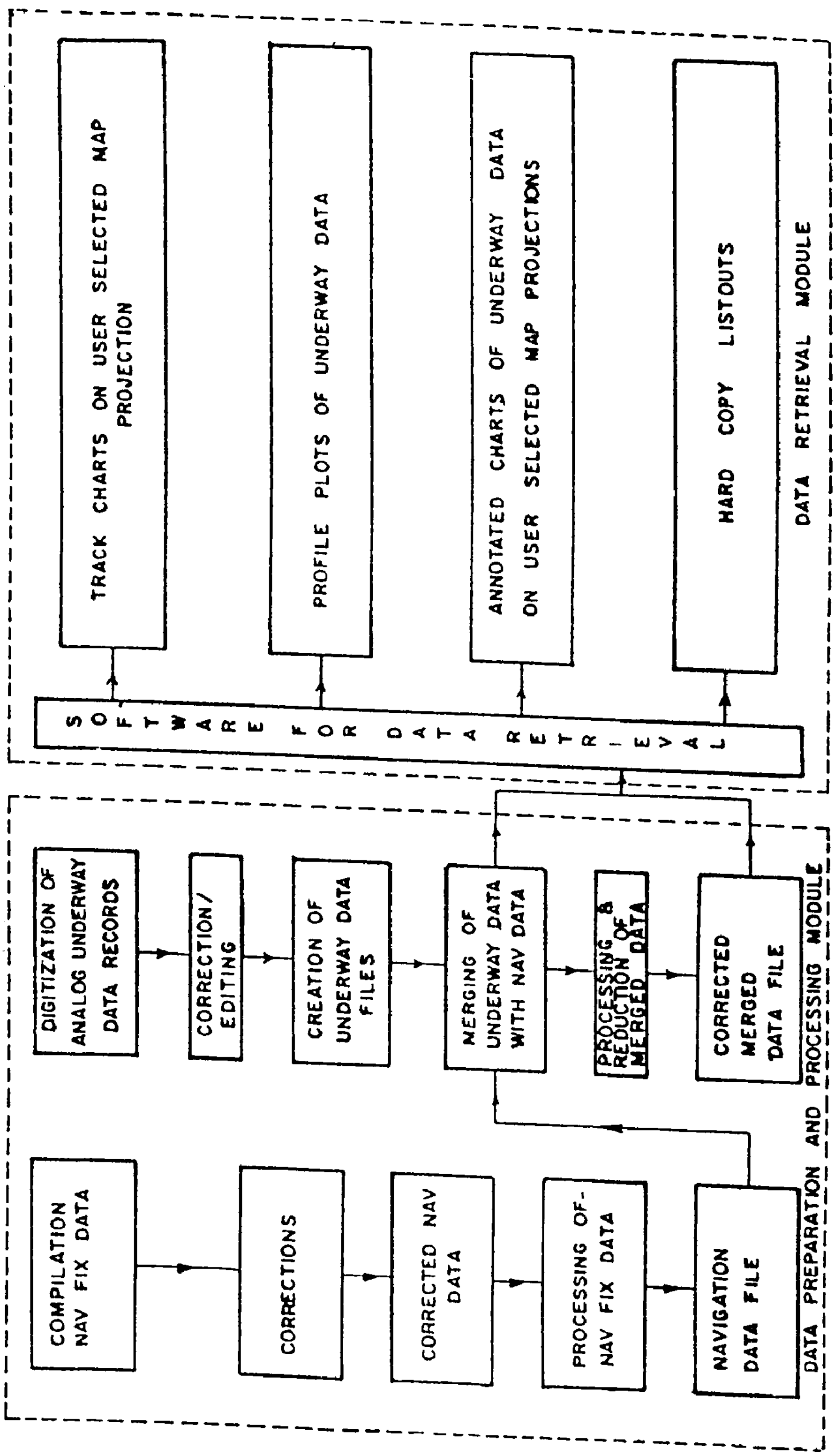

FIG. 2- Flow chart of the processing module employed.

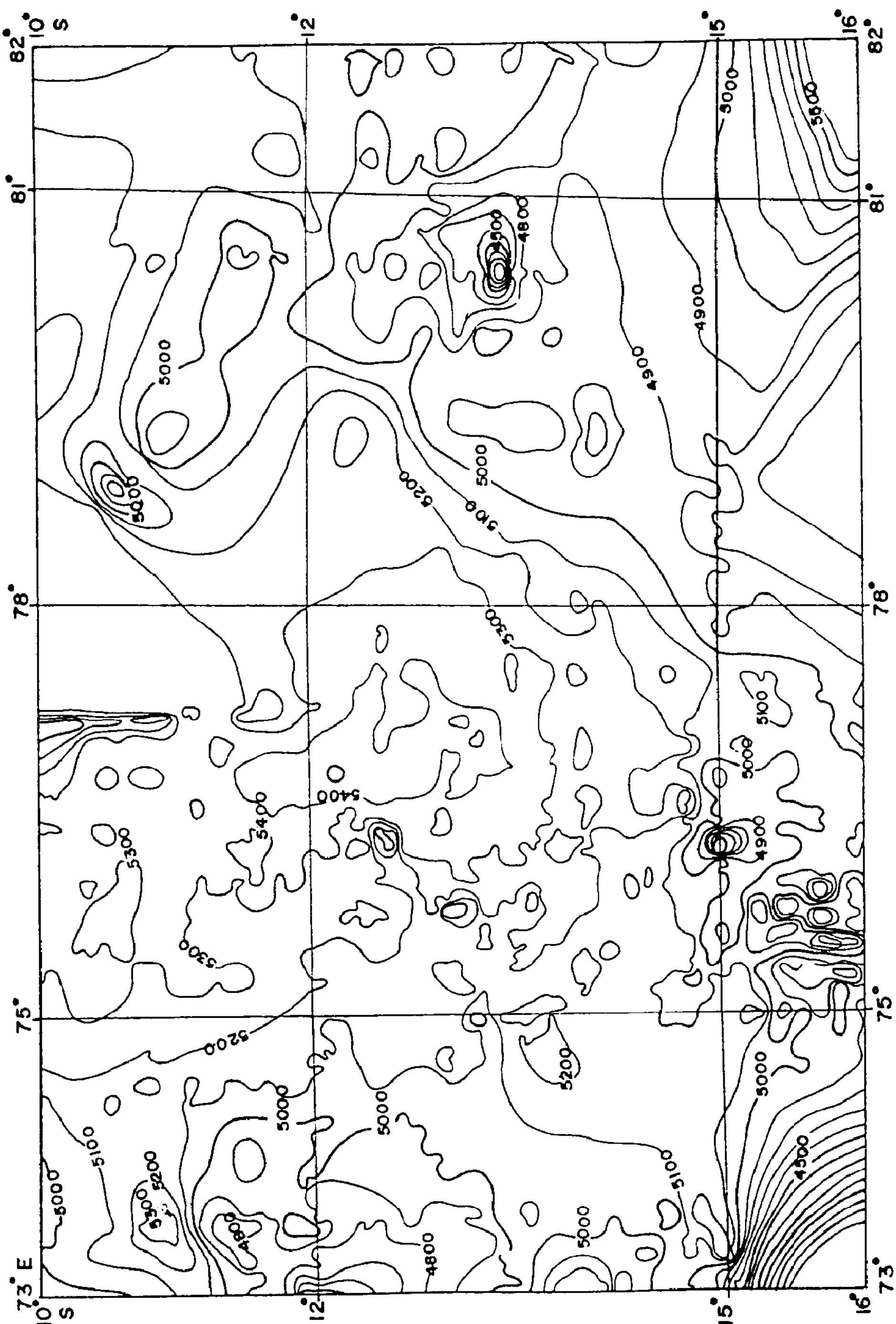

FIG. 3.- Hand drawn depth contour map of the area. Contour interval 100m.

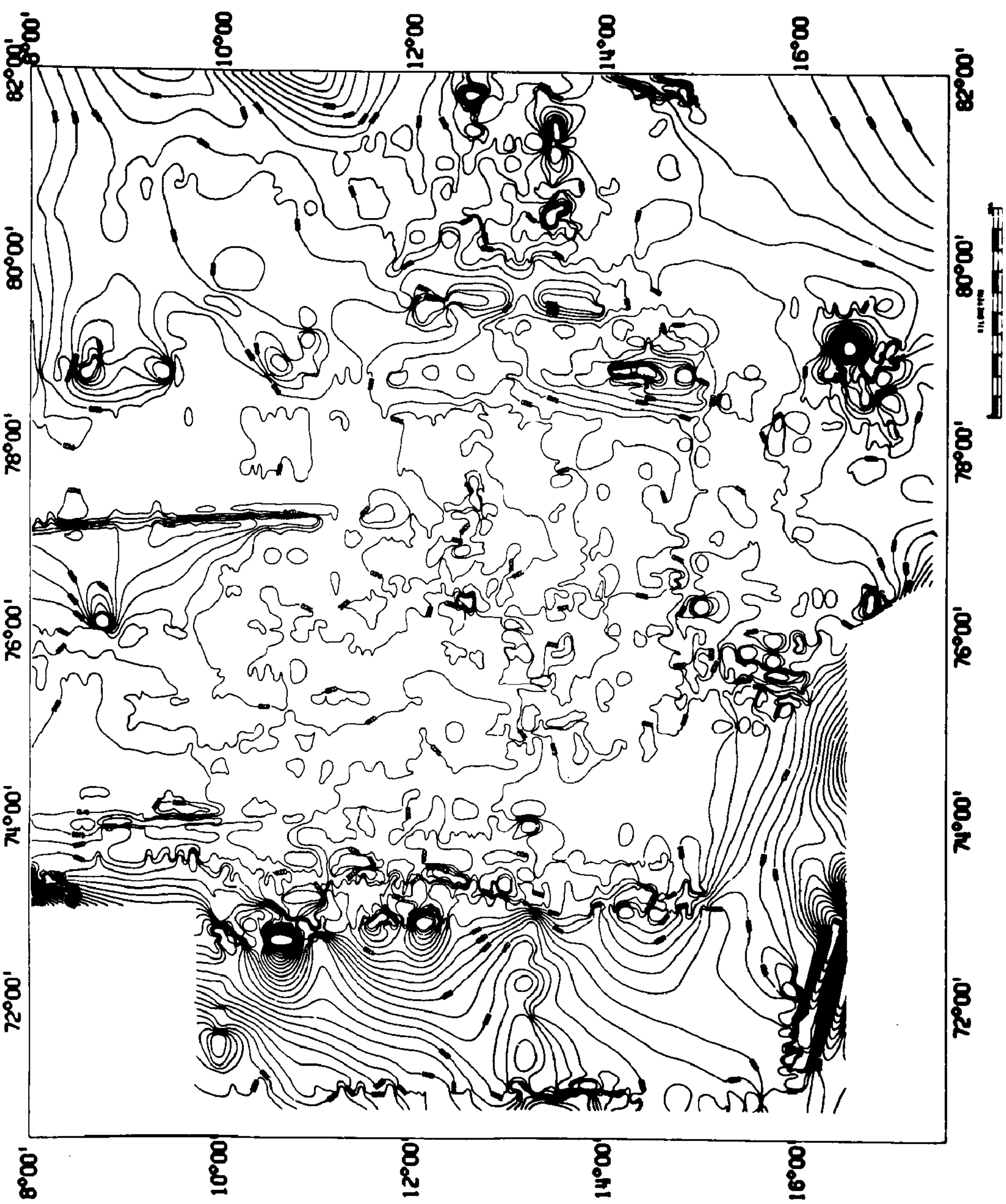

FIG. 4.- Depth contour map of CIB - drawn using GMS package.

revealed from this map. However, the seamount heights are not more than 1,500 m. The shallowest depth in the Basin is around 2,900 m. There are about 39 seamounts present in the basin (MUKHOPADHYAY and KHADGE, 1990). Most of the seamounts in the basin are conical (KODAGALI, 1989b). The seamounts follow a certain trend, normally NNE-SSW and are clustered around the fracture zones (KODAGALI, 1989b).

The data used for preparation of this bathymetric map is mostly from 30 nautical mile spaced echosounding lines. Obviously, much interpolation is done to prepare the map and features of less than 55 km dimension are not represented on this map. However, this map will serve as a base map for navigators and marine researchers for future surveys. To prepare an exhaustive detailed bathymetric map, a multibeam swath bathymetric system using the Global Positioning System (GPS) is essential. The Institute has already acquired a GPS and multibeam swath bathymetric surveys in the CIB are presently in progress. Initial results have shown that large features can be mapped with a fair amount of accuracy with single beam echosounding, whereas smaller features like seamounts and abyssal hills can only be deciphered accurately with multibeam surveys.

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