

NATIONAL INSTITUTE OF OCEANOGRAPHY

(Council of Scientific & Industrial Research)

DONA PAULA, GOA-403 004, INDIA



REPORT ON 59th OCEANOGRAPHIC CRUISE OF O. R. V. SAGAR KANYA (HYDROSWEEP SURVEY CRUISE I)

Project : POLYMETALLIC NODULES

Chief Scientist : GOVIND RANADE

Project Leader : R. R. NAIR

CRUISE PERIOD : 29th NOVEMBER, 1990 — 2nd JANUARY, 1991

CRUISE REPORT FOR CRUISE SK59
ON BOARD ORV SAGAR KANYA.

ITINERARY:

ETD	29.11.90	MARMAGOA	1800 HRS.
ETA	1.12.90	COCHIN	0430 HRS
ETD	3.12.90	COCHIN	1800 HRS
ETA	2.01.91	MARMAGOA	1030 HRS

LIST OF PARTICIPANTS FROM SCIENTIFIC CONTINGENT.

Sr. No.	NAME	DESIGNATION
1.	Shri GOVIND RANADE	Chief Scientist.
2.	Dr.R.MUKHOPADHYAY	Scientist C.
3.	Shri P.S. RAO	Scientist C.
4.	Dr.J.N. PATTAN	Scientist C.
5.	Shri R.BANERJEE	Scientist C.
6.	Shri N.V.AMBRE	STA.
7.	Shri TATA SUDHAKAR	STA.
8.	Shri V.D. KHEDEKAR	STA.
9.	Shri PIUS GEORGE	JTA.
10.	Shri B.VIJAYKUMAR	STA.
11.	Shri S.JAYSHANKAR	JTA.
12.	Shri UMESH KOCHARKAR	CMC Engineer
13.	Shri Pascol Pareira	JTA.
14.	Shri N.PAUL	TRAINEE
15.	Shri C.RAVI	-do-
16.	Shri MATHEW DAVID	-do-
17.	Shri M.SUBRAMANIYAM	-do-
18.	Shri G.M. CHANDAWALE	-do-
19.	Shri VIJAYKUMAR PATIL	-do-
20.	Shri PRAMOD	-do-

Trainees at sr. no. 19 and 20 disembarked at Cochin.

LIST OF SHIP'S COMPLIMENT FOR CRUISE SK59.

Sr. No.	Name	Designation
1.	Capt. R.D. SUDARSHAN	Master
2.	Capt. R.K. JAIN	Add. Master
3.	H.N. SHEWALE	C/E/ off.
4.	A.P. LAGVANKAR	2/E/ off.
5.	R.S. RAO	3/E/ off.
6.	A. MUKHOPADHYAY	4/E/ off.
7.	J. PRATAP	5/E/ off.
8.	M. SATISHKUMAR	AWKO
9.	O.J. SHEBY	TNO
10.	V. MOHANRAJ	Cadet
11.	A.M. THAMMAIAH	El./ off.
12.	M. DIAS	El./ off.
13.	L.M.F.	Ctr./ off.

Other than these officers, there were 42 other ship crew members present onboard for cruise SK59.

CRUISE REPORT.

Introduction: The cruise SK-59 onboard ORV SAGAR KANYA, was taken up under the project 'Survey for Polymetallic Nodules. In order to obtain detailed bathymetry information for the allotted mine-site and to decide on relinquishing part of the allotted area, as per UN sea bed authority agreements, Multibeam Swath bathymetry System was procured by NIO under the DOD grant-in-aid project. SK-59, was the second of the proposed five Swath Bathymetry cruises in the entire application area. It was proposed prior to beginning of the cruise to complete 14 lines of 300 nautical miles length. Subsequently due to delay in vessel's departure, it was estimated that 12 lines could be completed. Due to bad weather conditions during survey time, because the vessel had to divert from the survey area out of storm limits, only 11 lines data could be collected.

Equipment used:

Multibeam Swath Bathymetry System is a unique type of equipment for bathymetry data acquisition, covering large areas in a short time, compared to the conventional equipment like an echosounder. HYDROSWEEP, the multibeam Swath bathymetry system, provides a swath coverage of double the water depth in transverse direction. The transmission is facilitated through two transducer arrays, one in the longitudinal direction and the second in transverse direction in a planar T configurational. The arrays can be interchanged for transmission and reception functions as they are

identical. This interchanging facility is made use of for calculation of raybending parameters, by comparing the measurements made for the centre beam in transverse mode (survey mode), with those obtained in the fore-aft mode (calibration mode), by means of interactive computation. A fairly accurate mean sound velocity through water column can be obtained by this procedure, which is used in depth calculations from outer beams (oblique angles) which are corrected for refraction effects.

Transmitted and received beams are compensated for roll, pitch and heave motions of the vessel. This electronic beam steering process ensures that the received and processed data is stabilised against any movement of the ship and is position corrected.

A powerful processing system based on bit sliced processor architecture and around various sub processors (8088 based) which provides highly reliable bathymetry data, forms the heart of the system. It uses beam forming technique to obtain 59 performed beams, by using digital delay lines.

The calculations for horizontal distances, cross track deviations and to provide relative position for each depth point, the navigation data is interfaced to this system from the ships INS. With GPS also being interfaced to the INS, positioning has been very accurate.

The operator console provides the man machine interface required to initiate different control commands and required input data information like C keel values, gain level changes and

peripheral control commands. All the data acquired by the system is logged on to the magnetic tapes of 1600 bpi density for further data processing. The system operating frequency is 15.5 KHz. The accuracy of the system is better than .05 percent.

HYDROMAP:

The Hydromap system is used to post process the hydrographic measurements values that have been recorded with the Hydrosweep system. This facilitates, data input from tape to Hydromap system, position post processing, profile data or track data generation, 3D map generation and grid generation. The system is designed with EPR 1300 process computer, which has a bit slice architecture. A series of system programs like file manager (*FM) job generator (*JG), screen editor (*BTE), system operator (*SO), FORTRAN compiler and a FORTRON compiler, along with different functional programs for, position post processing, track data processing, area data processing, profile editing for specious data editing, banking editor for making off missing points, 3D map generation on graphic colour monitor provided with the system makes it a very powerful tool for postprocessing of hydrographic measurements.

The system comprises of Data Processing Console with computer interfaces for alphanumeric key board, monitor, graphic colour (VGA) monitor, magnetic tape drive for inputing of data, a colour matrix painter and a HP Draftmaster plotter.

Survey details:

After sailing on 29.11.90 at 1800 hrs, the Hydrosweep System was started at 23.00 hrs and data was collected on the track to Cochin. System was put off at 04.00 hrs on 1.12.90. Vessel went along side at 15.30 hrs near Cochin as the vessel called at Port Cochin for bunkers. Ship sailed from Cochin on 4.12.90 at 18.00 hrs. System was switched on at 21.00 hrs on track to Application area A for survey of 12 tracks. Vessel arrived line 1718 on 8.12.90 at 14.30 hrs. Weather was generally good for first 4 days. In the later part weather turned out to be rough and sea state was between 3 to 5 most of the time and on 2 to 3 occasions went upto sea state 6. Speed of vessel through out Survey was maintained at an average of about 8.00 to 8.50 knots. On beginning of line 2526 the weather turned very bad and a storm warning was received for area of operation. Master of the vessel took a decision to divert the ship into a safe zone from the vessel's safety point of view to an area 77° E and 13° 35' South. It was felt that line 2526 which was starting 9° 45' S to end point at 14° 45' S could be started from same point again as almost 20 to 22 hrs of travelling time would have been required. Also, it would have been impossible to complete all 12 lines as almost 24 hrs of time was wasted from survey point of view due to diversion of vessels planned tracks due to storm warning, It was then decided to take line 2526 from South to North and complete 11 total tracks. Last track No. 2728 was completed on 25.12.90 at 1800 hrs. As it was observed that we had about 16 to 17 hrs in hand and that it was not possible to complete one more track, a

decision was taken to survey 5 lines in Chagos Trench was of 28 to 30 miles each with a track to track separation of 3.6 nautical miles. Survey at Chagos started on 26.12.90 at 1811 hrs GMT and completed on 27.12.90 at 0118 hrs GMT. During the lines, the data processing was also taken up simultaneously and was successfully completed.

In total 10 maps of half degree by one degree ($1/2^{\circ} \times 1^{\circ}$), with 25 meters contour interval, 2 maps of complete area with 50 and 100 meter contours each and 2 maps with 1° longitude by $2 1/2^{\circ}$ latitude were generated for the track survey area.

On completion of Chagos area, then the vessel was on the track back to Marmagoa, the system was run up to $1^{\circ} 45' N$, $75^{\circ} 45' E$. System was again switched on at 01215 hrs on 31.12.90 at $7^{\circ} 20' N$ and $75^{\circ} 45' E$ for the proposed track from $8^{\circ} 10' N$ to off Marmagoa.

System Performance:

The system worked satisfactorily during entire survey period. GPS was not available on two occasions for about 15 to 20 minutes, in survey area. It is felt that, receiver group for beam numbers from 15 to 22 (3rd group on port) did not behave properly and in general for slightest disturbance in weather only port side beams were affected. Also, an important point from point of Vessel's behaviour noticed was, that the vessel has a listing problem on port side. At times she listed to about 6° to 7° from normal and remained in that position for few hours. In such conditions, it was necessary to reduce the speed of vessel below 8 knots. This

was one of the factor for not completing the target of 12 lines. It was informed by the Captain and the Chief Engineer that vessel cannot be run around 150 RPM, which gives a speed of 10 knots, ideal for Hydroseep. As this was not possible, the vessel was run on 3 generators most of the time giving an average speed of 8.5 to 8.75 knots. These two points from vessels operation must be considered for the future safety of vessel. Navigation had been excellant and cross Track Error (CTE) was always maintained less than 7 to 8 meters for almost all the time.

Results:

During the cruise, detail bathymetric survey of a small segment of the seafloor was carried out with multibeam hydrosweep equipment. Bathymetric data along eleven N-S profiles, each of 300 nautical miles long and separated by 5 nautical miles, was collected. The area covers between latitude 9° 45'S to 14° 45'S and longitude 75° 42'E to 76° 38'E.

The seafloor of the surveyed area has a number of seamounts, small ridges and swells, valleys, guyots. Larger seamounts occur mostly in the southern part of the surveyed area. The tallest seamount encountered have a height of 1170m. Two major seamounts (height (h) > 1000m), ten intermediate (h = 500 - 1000m) and 9 minor seamounts (h < 500m) occur in the area south of the latitude 12° 15'S. In contrast, the northern part of the surveyed area (i.e. north 12° 15'S latitude) have only minor (4 nos) and intermediate (1 no) seamounts. No major seamounts occurs in the northern part. However, this part shelters weak or faint traces of N-S trending parallel ridges. It appears that these ridges were lost towards south in the crumpled seafloor. Crumpling and folding of the seafloor become prominent south of the 10° S latitudes. These have E-W trending axis and are arranged alternately with valleys/trenches rendering the seafloor a shape near to the highly corrugated. The height and fall of these E-W trending crumpled seafloor vary from 50m to 600m. Intense crumpling (E-W, ESE - WNW) axis trending of seafloor continues upto latitude 12° S. South of 12° S latitude crumpling reduces, and intermediate to major seamounts start to appear.

Several 2-dimensional contour maps and 3-dimensional maps of the seafloor were produced to get an overview of bathymetry of the surveyed area. Besides, profiles and cross sections across different interesting features were plotted, printed and studied. Seamounts are circular to semi-circular in shape and mostly have pointed peaks. Summits of atleast five seamounts appear in the shape of crater with the central portion subsided to a depth between 200 and 250m. Bathymetric profiles across these summits confirms crater morphology. Further detail study of these seamounts would be of much importance.

During return journey back to Goa, roughly about 24 hours was spent on southern part of Chagos-laccadive ridge. This ridge is very significant from tectonic point of view for its origin by Reunion hotspot over the gliding of Indian plate in geological past. Present multibeam survey was made perpendicular to the ridge extension. Data from six profiles of variable length (20 nm to 30 nm) at a spacing of 3 nm were collected. The surveyed area is roughly bounded by latitude 5° S to 5° 35' S and longitude 73° 25' E to 74° E. Data collected from south-western and eastern side of the ridge shows a difference of depth between more than 5250m on the eastern abyssal plains to shallower than 2650 m on the top of the Chagos ridge. This is probably the first time when such a detailed 3-dimensional bathymetric view of Chagos ridge is generated. The rise in bathymetry is very sharp; ridge summit, except at the margin, is found to be smooth.

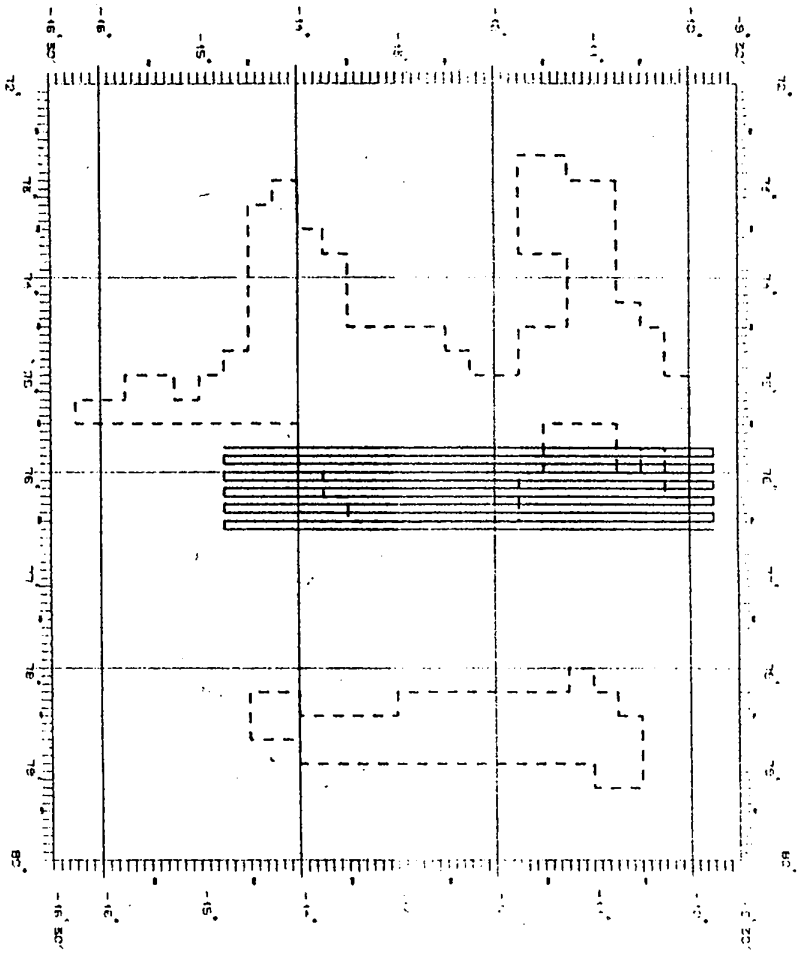
Further study and detail interpretation of the bathymetric features found as a result of the present cruise are on and some more surveys of this nature would be required to understand both

the topography of the Indian Ocean as well as the Indian Ocean tectonism.

ORV SK - 59 Line Details

Date	GMT	Lat	Long	Line No	Remarks/Line Name
29/11	0230	13 08'N	75 58'E	B.O.L 1	Goa-Cochin
04/12	0230	6 45'N	75 47'E	B.O.L	CHN-CIB
04/12	1840			B.O.L. 2	CHN-CIB
04/12	2034	4 30'N	75 35'E	B.O.L 4	CHN-CIB
05/12	1409			B.O.L 5	CHN-CIB
08/12	0830	9 45'S	76 35'E	B.O.L 1718	1st Survey line
09/12	1656	14 45'S	76 35'E	B.O.L 1819 Tie	Tie line 1718.
09/12	1727	14 45'S	76 30'E	B.O.L 1819	2nd Survey line
11/12	0216	9 45'S	76 30'E	B.O.L 1819 Tie	Tie line 1819.
11/12	0249	9 45'S	76 25'E	B.O.L 1920	3rd Survey line
12/12	1302	14 45'S	76 25'E	B.O.L 1920 Tie	Tie line 1920
12/12	1329	14 45'S	76 20'E	B.O.L 2021	4th Survey line
13/12	2157	9 45'S	76 20'E	B.P.L 2021 Tie	Tie line 2021
13/12	2225	9 45'S	76 15'E	B.O.L 2122	5th Survey line
15/12	0942	14 44.9'S	76 14.9'E	B.O.L 2122 Tie	Tie line 2122
15/12	1009	14 45'S	76 10'E	B.O.L 2223	6th Survey line
16/12	1950	9 45'S	76 10'E	B.O.L 2223 Tie	Tie line 2223
16/12	2020	9 45'S	76 05'E	B.O.L 2324	7th Survey line
18/12	0708	14 45'S	76 04'E	B.O.L 2324 Tie	Tie line 2324
18/12	0736	14 44'S	75 59'E	B.O.L 2425	8th survey line
19/12	2032	9 45'S	75 59'E	B.O.L 2425 Tie	Tie line 2425
19/12	2103	9 45'S	75 55'E	B.O.L 2526(I)	

20/12		10 43.3'S	75 55'E	E.O.L 2526(I)	9th Survey line
21/12	0350	14 45'S	75 55'E	B.O.L 2526(II)	
22/12	1630	9 45.7'S	75 54'E	B.O.L 2526 Tie	Tie line 2526
22/12	1701	9 45.02'S	75 50.2'E	B.O.L 2627	10th survey line
24/12	0248	14 44.7'S	75 50'E	B.O.L 2627 Tie	Tie-line 2627
24/12	0319	14 44.9'S	75 45.2'E	B.O.L 2728	11th survey line
25/12	1516	9 45' S	75 45'S	B.O.L 1001SK59	Survey area to SM place.
25/12	2308			B.O.L 1003SK59	SM place to Chagos trench.
26/12	1811	5 31.9'S	73 57.9'E	B.O.L 1004SK59	CTR 1st Chagos line.
26/12	2125	5 14.4'S	73 25.9'E	B.O.L 1004 Tie	Tie line 1004
26/12	2150	5 10.8'S	72 25.9'E	B.O.L 1005SK59	2nd Chagos line
27/12	0125	5 28.8'S	74 00.2'E	B.O.L 1005 Tie	Tie line 1005
27/12	0144	5 26'S	74 01'E	B.O.L 1006SK59	3rd line Chagos
27/12	0429	5 11'S	73 35'E	B.O.L 1006 Tie	Tie line 1006
27/12	0450	5 08'S	73 36'E	B.O.L 1007SK59	4th Chagos line
27/12	0804	5 22.2'S	74 01.7'E	B.O.L 1007 Tie	Tie line 1007
27/12	0836	5 19.7'S	74 04.2'E	B.O.L.1008SK59	5th Chagos line
27/12	1142	5 06'S	73 38'E	B.O.L 1009SK59 CTR GOA	CIE to GOA Chagos to GOA
29/12	0118	00 59'N	75 54'E	B.O.L 1010SK59 CTR GOA	Towards Goa
29/12	0925	02 10'N	75 55'E	B.O.L 1011SK59 CTR Goa	Towards Goa



SCALE: 1:500000

PROJECTION: MERCATOR

REFERENCE LAT.: 0.00 (NAD-72 SPHEROID)

NATIONAL INSTITUTE OF OCEANOGRAPHY

TRACK PLOT SK-69

CHART: AREARLOT

HYDROGRAPH DATA

DATE: 2-10-71