

**NATIONAL INSTITUTE OF OCEANOGRAPHY**  
(Council of Scientific & Industrial Research)  
Dona Paula – Goa 403 004

**REPORT**  
**OF**  
**ELEVENTH OCEANOGRAPHIC CRUISE**  
**OF**  
**ORV SAGAR KANYA**

**(27 October to 10 December, 1984)**

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1.0 PARTICIPANTS

NATIONAL INSTITUTE OF OCEANOGRAPHY

~~1. Shri P. S. Rao Chief scientist~~

2. Shri V. N. Kodagali

3. Shri V. Ramaswamy

4. Shri N.P.C. Reddy

5. Shri J.N. Pattan

6. Shri S. Nagendra

7. Shri K. Sreekrishna

8. Miss Pratima Jauhari

9. Shri D. Prabharan

10. Shri P. Ganeshan

11. Shri D. K. Naik

12. Shri R.A.A. Luis

13. Shri J. Kannayan

14. Shri Fernando Vijayan

15. Shri V.S. Rajaraman

16. Shri B. Vijaykumar

17. Shri M. Suresh Raj

18. Shri R. G. Prabhu Desai

NATIONAL GEOPHYSICAL RESEARCH INSTITUTE, HYDERABAD

19. Shri R.K. Drotia

20. Shri P. John Paul

21. Shri N. Chandrasekar

JADAVPUR UNIVERSITY

22. Shri Subir Mukhopadhyaya

KERALA UNIVERSITY

23. Shri Darma Raj

2.0 SHIP'S COMPLIMENT

1. Capt. S. S. Kumar - Master
2. A. K. Dass - C/O
3. U. <sup>G</sup> P. Dixit - Second Officer
4. S. L. Dabhoya - Third officer
5. ~~E. F. D'Silva - Fourth Officer~~
6. S. Bhattacharya - C/R/O
7. M. D. Das - R/O
8. K. Sethu<sup>m</sup>adhavan - Purser
9. Dr. K. Rajbalan - Medical Officer
10. U. N. Singh - C/E/O
11. Sanjeet Singh - 2/E/O
12. A.V.S.D.N. Rao - 3/E/O
13. K.T.Kumar - 4/E/O
14. S. Ramanathan - 5/E/O
15. G. S. Rai - EL/O
16. S. L. Verma - EL/O
17. T. K. Anthony - DK/Sarang

### 3.0 INTRODUCTION

As in the earlier cruises of RV Gaveshani, MV Skandi, Surveyor, MV Farnella and ORV Sagar Kanva, the aim of the 11th scientific cruise of ORV Sagar Kanva was to collect geological and geophysical data in the Central Indian Ocean for the project 'Surveys for Polymetallic Nodules'. The cruise was planned for forty five days preceeding which there was a trial cruise for lubricating the deep sea winch wire, to train the marine surveyors with ~~ATNAV and to calibrate EMS log~~.

The vessel sailed on 20th October from Mormugao and came back on 24th October <sup>after trial cruise</sup> and proceeded to the Central Indian Ocean on 27th October, 1984, and returned back on 10th December, 1984.

Though the proposed plan of work included deep sea photography, it could not be carried out because of the failure of the deep sea winch. The entire ship's time was utilised for sampling and geophysical surveys. As many as seventy two stations were completed of line kilometers of bathymetric, gravity and magnetic data were collected. Gravimeter was off in the last 10 days because of the transisters failure.

### 4.0 TRIAL CRUISE

The trial cruise was planned for 4 days off Mormugao to lubricate the winch wire, to train the marine surveyors with ATNAV system and to calibrate the EMS log.

Ship sailed on 20th October at 1800 hrs. and reached a position of safe depth 2000 m to lubricate the wire. Lubricating oil was applied continuously on friction winch drums to the entire length of the wire. Even after this winch was not under condition

for deep sea work. ATNAV transponders were dropped with a mooring weight at a depth of 80 m and all the surveyors on board were familiarised how to operate the system. For EMS log calibration vessel came into the miniranger's range twice and no signal was received. So EMS log calibration could not be done.

Besides this, some of the scientific operations were demonstrated for shooting for the film "Oceanography in India" for CSIR. After completing the job vessel entered Mormugao on 24th October, 1984 at 06.00 hrs.

### 5.0 POSITION FIXING AND INTEGRATED NAVIGATION SYSTEM

Position fixing was done by Integrated Navigation System (INS) which receives data from a dual channel MX 1107 Satnav, Doppler sonar and a gyro. Accuracy of the position is  $\pm 50$  m. Various components and functions of INS are discussed below

#### Integrated Navigation System

This system consists of a navigation computer (HP2117F) and connected peripherals. This computer provides accurate positioning from the integration of the Navy Navigation Satellite System, the Radar navigation system, the Krupp/Atlas sonar, the Anschutz gyro and other navigation sonars. The navigation system serves as the processing and control unit which accepts data from and provides control to the devices attached to it and communicates with the system operator. The following are the sensors connected to the computer :

1. Sonar/Gyro: The system includes a Krupp Atlas Dolving 12 sonar and an Anschutz gyro for accurate determination of vessel velocity. The sonar provides velocity information in the ships axes co-ordinates and the gyro is used to convert this information

to geod<sup>ic</sup> N-S velocity.

2. Model 40 Multiflexer: This permits inpass from echosounder, magnetometer and gravimeter

i) 1107 sat. receiver/1105 sat. omega receiver :

These two receivers acquire<sup>s</sup> and track<sup>s</sup> signals transmitted by the transit satellites. Computer will compute the dead <sup>eko</sup> ~~fix~~ rings data with the fix data and estimates the position of the vessel accurately.

ii) Gravimeter : The navigation system transmits general navigation data to the Bodensuwerk gravimeter at 5 seconds interval. The gravimeter sends time, sea state, gravity ~~are any~~ <sup>s</sup> corrected gravity, free air, bouguer values to the navigation system.

iii) Echosounder: This system contain three separate ~~echosounders, deep-sea, narrow-beam and shallow-water~~ ~~Depths~~ from all these echosounders will be logged on magnetic tapes. However one depth will be chosen for display.

#### Output devices

a) Magnetic tapes: These are used to record various types of data discussed above in different records at every six seconds.

b) Printers: A copy of the recorded data can be obtained from the printer by selecting suitable time interval.

c) Plotter: It provides an analog display of the ships position with reference to time. It gives the ship's track and position of the shot such as dropping of boomerangs.

#### 6.0 DATA PROCESSING

HP 1000 computer with HP 7580 plotter was used for data



processing. Programme packages available for the correction of the raw data for corrected position, depth and gravity etc. was used. Depth<sup>vs</sup>/time along with position, speed vs time were plotted. To and fro cruise track was also plotted. After all corrections print out was taken for interpretation of data.

## 7.0 MARINE GEOLOGY.

### 7.1 Bathymetry

Honey well Eiac shallow water echosounder, narrow beam echosounder, deep sea pinger echosounder were used for bathymetric data. The NBS consisted of a three frequency (12, 20 and 30 KHz) gyro stabilised transducer, LAZ72 main recorder which serves as master and a slave recorder. The DPS consisted of a main recorder, pinger synchroniser and echo strength measuring unit. Both the systems are provided with digital display units mounted on these and remote control analogue recorders fitted in different laboratories.

Shallow water echosounder was operated with 150 KHz frequency below 200 m depths. DPS was used for a short period to measure the echo strength and NBS was operated throughout <sup>the</sup> cruise at 12 KHz frequency. The bathymetric data was received by navigational computer and recorded on magnetic tape. A total of 12,790 km of bathymetric data was collected. On the way to Central Indian Ocean and back to Marmagoa, the vessel crossed the western continental margin of India, a part of Ganges cone and <sup>the</sup> abyssal plain.

Indian western continental shelf break occurred at a depth of 13 m and continental slope ended at a depth of 1750 m, while crossing the continental slope at Lat 9 18'N, Long 75 28'E.

suddenly depth started<sup>e</sup> reducing to 478 m recording a seamount of 1000 m and further till the end of the slope depth continuously increased. On the Ceylon abyssal plain there was not much variation in the depth and topography remained more or less smooth. However on abyssal hill of 600 m higher was noticed at Lat 13° 30' N, Long 77° 20' E.

In the survey area before reaching the sampling stations a sea mount of 1000 m height<sup>e</sup> with steep flanks was recorded. In general the depth varied in<sup>(</sup>between 4,600 m and 5,400 m in the survey area. Topographic elevations of the order of 200 to 300 m are common. Many of the stations covered lie in the depths 4800 m to 5300 m. At four stations the depth varied as much as 200 m within the area of samplers dropped. A thousand meters 'V' shaped valley like features was noticed at Lat. 13° 00' S, Long. 73° 14' E. The topography in the western part of the survey area is rough and abyssal hills are more common through the eastern part. Another valley of 1200 m was recorded west of the survey area at Lat. 13° 01' S and Long. 72° 40' E.

The two sea mounts sampled were located at Lat 13° 17' S, Long. 70° 57' E and Lat. 13° 01' S, Long 72° 10' E. The height<sup>e</sup> of the ~~first sea mount is 1,665 m and flanks are very steep either~~ side. The second one is 928 m higher and flanks are similar to the earlier one. This has got 2 peaks, second one is less in height and developed on one of the flanks. After sampling <sup>these is a</sup> sea mounts on the way to bathymetric lines at Lat 12° 44' S, Long. 72° 35' E a sea mount of 1450 m height by the side of a valley with topographic irregularities on either side was recorded. At the

peak of the sea mount the depth was <sup>3</sup>538 m and in the valley 5630 m, whereas the general depth in that area was 4750 m.

In the area of bathymetric lines abyssal hills and topographic elevations of the order of 200 m were recorded at some places, other than this sea bed remained smooth and general depth varied between 4900 m and 5300 m.

On the way back depth remained at 5000  $\pm$  100 m from 10 S to 4 S and then onwards started slowly reducing. At the equator the depth was 4250 m and ~~continued reducing~~ <sup>continuously reduces</sup> as the vessel proceeded towards north on the Cylon abyssal plain. Off Cochin at Lat 10 N, Long 74 40'E the depth was 2290 m and continued with minor changes since ~~course~~ <sup>u</sup> fall parallel to the coast. However, at Lat 10 40'N and Long 74 42'E suddenly depth started ~~reducing~~ <sup>e</sup> indicating the shelf break. At Lat. 11 37'N, Long 74 45'E the depth was 89.9 m and reduced further as vessel came near the coast. Echosounder was put off at 22 m depth near Mormugao Port.

## 7.2 Sampling

Sampling was carried out with free fall samplers (Boomerang grabs and Photo boomerang grabs). In all 72 stations were completed with seven boomerang grabs including two photo boomerangs at each station. Samplers were dropped in hexagonal pattern i.e. six in the corners and one at ~~the~~ <sup>the</sup> centre. However two stations lie on seamounts and 6 samplers were dropped at each station, two top, two on the flanks and two at the bottom of the seamount. Out of 12 boomerang grabs operated only two brought sample.

A total <sup>number</sup> of 490-boomerang grabs were lowered including 139 photo boomerangs in 70 stations which lie in the survey area.

There was no recovery in one station and at twenty one stations abundance was less than one kg/m<sup>2</sup>. In these stations most of these grabs brought either ~~nil~~ <sup>no sample</sup> or traces. At 35 stations concentrations was 1 to 5 kg/m<sup>2</sup>, at 7u stations 5 to 10 kg/m<sup>2</sup> and at 6 stations more than 10 kg/m<sup>2</sup>. Highest concentration 13.17 kg/m<sup>2</sup> was found at station SK XI/131 closely follow<sup>d</sup> by station SK XI/110 having 13.05 kg/m<sup>2</sup>. Operation wise 236 boomerangs represented either nil or less than 1 kg/m<sup>2</sup> abundance and 149 boomerangs 1 to 5 kg/m<sup>2</sup> whereas 108 boomerangs showed more than 5 kg/m<sup>2</sup>. Maximum recovery from a single grab was 4.6 kg indicating 39.38 kg/m<sup>2</sup> abundance at station SK XI/131.

pieces  
found  
at  
ground  
places  
by  
the  
different

In general the nodules vary widely in shape and size and also in texture. The size ranges from peanuts to potatoes shape. Some of the crusts collected from the grab is as <sup>big</sup> ~~big~~ as a ballast weight. ~~Small sediment trap in the grabs.~~ In the southern part of the area where the nodule concentration is higher comparatively red clay is abundant. At a few stations in the western part calcareous <sup>sediment</sup> ~~soil~~ is found.

### 7.3 Photography

Though lot of sea bed photography with Benthos underwater camera was plan<sup>n</sup>ed for this cruise, it had been restricted to Preussag underwater boomerang cameras due to the deep sea winch failure. At each station one camera with colour film and one with B/W film were operated. At some stations slide film was used.

Out of 139 photo boomerangs ~~totally~~ operated, 35 operations were not successful due to malfunctioning of cameras. 12 slide

photographs and 14 colour and B/W photographs were lost along with three phot<sup>P</sup>boomerangs. A good correlation between the nodules rec<sup>V</sup>ferred from the grab and corresponding photograph is observed. Some of the photographs revealed biological activity. The maximum coverage of nodules observed in the photographs is about 50%. The B/W films were developed and printed onboard Sagar Kanya using the facilities available.

## 8.0 MARINE GEOPHYSICS

A total of 9,528.54 lkm of magnetic data and 7,217.24 lkm of gravity data <sup>f</sup>along with 12,790 lkm of bathymetric data were collected during the cruise. Magnetic data was collected with geometrics G801/S model proton precision magnetometer. The magnetic sensor was towed 300 m away along the s<sup>h</sup>ips track to avoid the noise caused by the vessel. Recording equipment which was mounted in Geophysical laboratory was connected to the sensor with a cable. Total <sup>f</sup>magnetic intensity in gammas was measured at a sampling rate of 3 sec. The observed data was recorded on magnetic tape through navigation computer and an analog record was also collected.

Gravity data was collected by Bodensee<sup>N</sup>per<sup>k</sup> digital sea gravimetr<sup>e</sup> system RSS30. Gravity, free air and bouguer values in milliga<sup>l</sup>s were measured on a stable <sup>P</sup>platform. The data also was recorded on the magnetic tape. A teletype print out with data, position, measured gravity, velocity of the vessel, water depth, coetvos effect, free air and bouguer values were taken for every five minutes. Absolute gravity value at Mormugao port berth No.6 (GABS-9783599.7) was entered. Measured gravity at the harbour was observed for a day at the port and the average value (GH-2221.3)

was entered as measured value. An analog record of online free air and bouguer values was also taken to monitor the data.

8.1 Magnetics: The shelf area was marked with high frequency anomalies of the order of 200 to 300 mts. Afterwards broad wave length low frequency anomalies were observed. On the slope at Lat.  $9^{\circ} 18' N$ , Long  $75^{\circ} 28' E$  a  $100 \text{ nT}$  anomaly was observed because of a seamount. Still further south there was not much change in depth but 325 nt decrease in the magnetic intensity was recorded. Similarly at Lat.  $7^{\circ} N$  and Long  $76^{\circ} E$  240 nt decrease was observed. An abyssal hill of 400 m high was reflected by increase of  $160 \text{ nT}$ s at Lat  $3^{\circ} 40' N$  Long  $76^{\circ} 45' E$ . A  $100 \text{ nT}$  increase of an abyssal hill at Lat.  $2^{\circ} 57' N$  Long  $77^{\circ} 23' E$  were recorded. Abdt  $300 \text{ nT}$  increased in the total magnetic value at Lat  $3^{\circ} 50' S$ , Long  $78^{\circ} 35' E$  and  $470 \text{ nT}$  increase at Lat.  $4^{\circ} 15' S$  and Long  $78^{\circ} 40' E$  were recorded with out any bathymetric variations.

In the survey area at Lat.  $10^{\circ} 10' S$ , Long  $80^{\circ} E$  a sea mou~~nt~~ was noticed but no magnetic anomaly was observed. At Lat.  $14^{\circ} 34' S$ , Long  $81^{\circ} 30' E$  magnetic intensity was increased by  $350 \text{ nT}$  with out any change in topography. Similarly at Lat.  $14^{\circ} 42' S$ , Long  $80^{\circ} 57' E$ , Lat  $15^{\circ} 55' S$ , Long  $76^{\circ} 43' E$  and Lat  $15^{\circ} 15' S$ , Long  $76^{\circ} 02' E$   $400 \text{ nt}$ ,  $450 \text{ nT}$ , and  $350 \text{ nT}$  were decreased respectively without any bathymetric change. Many of the abyssal hills and topographic features were not reflected in the magnetic anomalies in the western part of the survey area. On the way back broad wave length anomalies ranging from  $50$  to  $200 \text{ nT}$  were observed at  $12^{\circ} S$  representing a deeper portion of 400 m. At Lat.  $3^{\circ} 50' S$ , Long  $74^{\circ} 55' E$  a seamount was reflected in magnetic anomaly by decrease

of 300 n/s. Further north Indian western continental margin was characterised by high frequency anomalies of the order of 300 to 400 n/s.

8.2 Gravity: A sharp increase in bouguer anomaly about 65 mgals was recorded on the shelf break and another sharp increase was marked in both free air and bouguer anomalies by the end of the slope. The seamount which reflected in magnetics on the slope caused an increase of 30 mgals in free air and 60 mgals in bouguer values. At Lat. 8° 35' N, Long 75° 38' E gravity was increased by 40 mgal and free air, bouguer values were decreased by 35 and 75 mgals respectively representing a topographic irregularity. A gravity high of 45 mgals was observed at Lat. 14° 45' S, Long 80° 40' E and a decrease of 65 mgals was recorded at Lat. 15° 15' S, Long 76° 45' E. The seamount which did not reflect in magnetic anomaly caused an increase of 50 mgals at Lat 15° 10' S and Long 74° 58' E. At Lat. 14° 14' S, Long 73° 45' E there was a decrease of 60 mgals with out any variation either in bathymetry or magnetics.

#### 9.0 LOSSES AT SEA

Six boomerang grabs and three photoboomerang grabs were lost along with 9 radio markers and 4 lamp beacons. Out of 9 samples lost 6 did not surface and 3 came up but hit the hull while manoeuvring the vessel and sunk. For all boomerangs fully charged radiomarkers and lamp beacons during the night operations were used. Usual search was done for five hours at each station where losses occurred. Apart from this one boomerang buoy ~~along~~ without a grab was lost during the trial cruise. The loss report has been given to the head quarters immediately after completing the

cruise.

10.0 ANNEXURES

10.1 Details of operations

Station No	Equipment operated				Remarks
	Boomerang	Photoboomerang	Photo sledge	Dredge Others	
92	X		X		
93	X		X		
94	X		X		
96	X		X		
97	X		X		
98	X		X		
99	X		X		
100	X		X		
101	X		X		
102	X		X		
103	X		X		
104	X		X		
105	X		X		
106	X		X		
107	X		X*		
108	X		X		
109	X		X		
110	X		X		
111	X		X		
112	X		X		
113	X		X		
114	X		X		



115	X	X
116	X	X
117	X	X
118	X	X
119	X	X
<del>120</del>	<del>X</del>	<del>X</del>
121	X	X
122	X	X
123	X	X
124	X	X
125	X	X
126	X	X
127	X	X
128	X	X
129	X	X
130	X	X
131	X	X
132	X	X
133	X	X
134	X	X
135	X	X
136	X	X
137	X	X
138	X	X
139	X	X
140	X	X
141	X	X

143	X	X
144	X	X
145	X	X
146	X	X
147	X	X
148	X	X
149	X	X
150	X	X
151	X	X
152	X	X
153	X	X
154	X	X
155	X	X
156	X	X
157	X	X
158	X	X
159	X	X
160	X	X
161	X	X
162	X	X
163	X	X

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#### 10.2 List of figures

- Fig.1 Map showing the pattern of dropping the sample
- Fig.2 Bathymetry ~~is~~ plotted by the computer
- Fig.3 Shelf break plotted by the computer
- Fig.4 Sea bed photograph showing the concentration