

# CRUISE REPORT

ORV SAGAR KANYA

Cruise No. 125

(25 July to 25 August, 1997)



राष्ट्रीय समुद्र विज्ञान  
संस्थान

**NATIONAL INSTITUTE  
OF  
OCEANOGRAPHY**

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**Cruise No. 125**

(25 July to 25 August, 1997)

**NATIONAL INSTITUTE OF OCEANOGRAPHY**

(Council of Scientific and Industrial Research)

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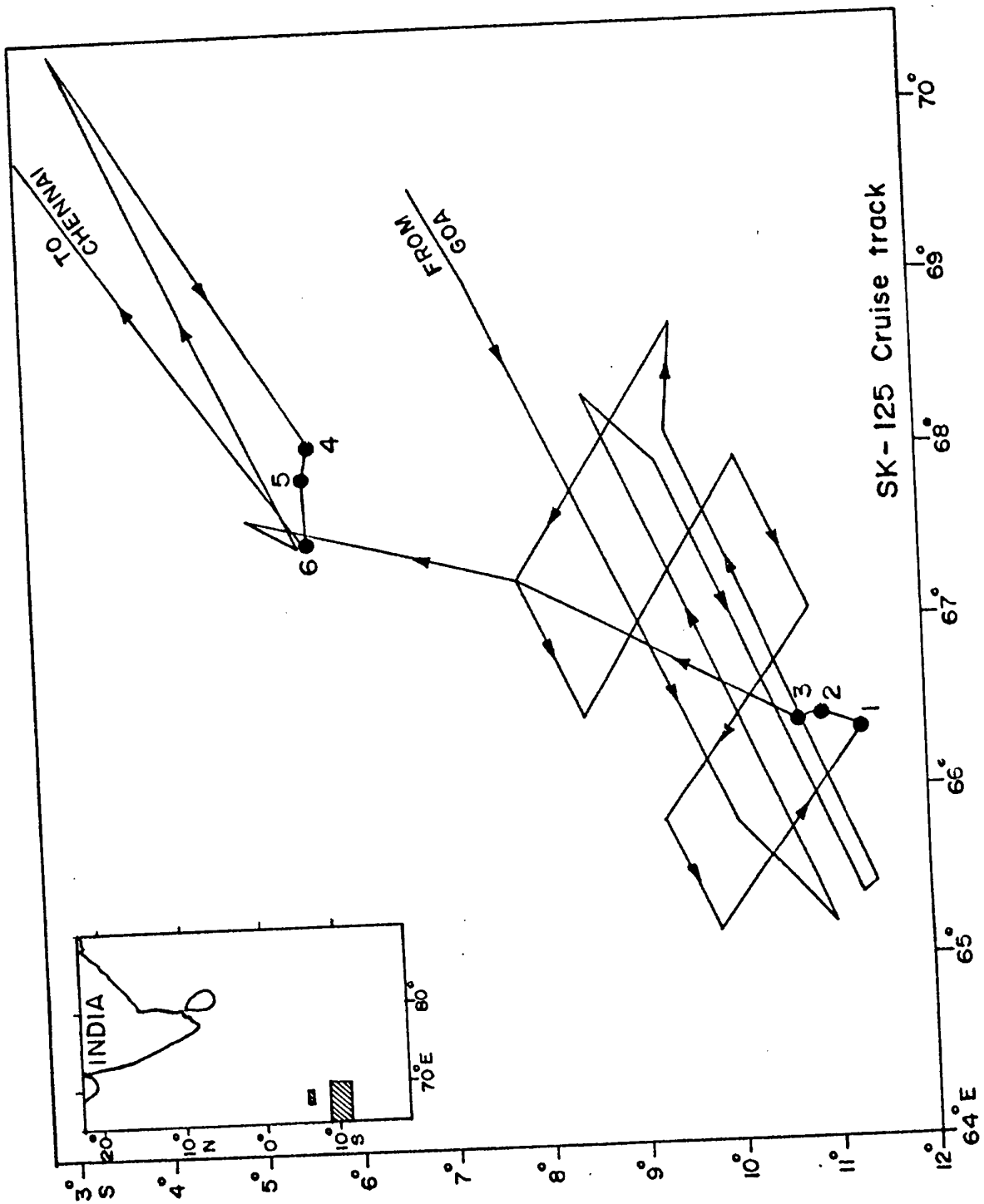
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# REPORT ON THE 125TH OCEANOGRAPHIC CRUISE OF ORV SAGAR KANYA

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## 2. CRUISE SUMMARY

The research vessel Sagar Kanya sailed off Mormugao harbour on 25 July, 1997 towards the Indian Ocean region for the study of Central Indian Ridge (CIR). A detailed tectonic and petrological studies were planned. However, due to non-availability of a couple of equipments and slow ship speed, the plan was modified as below:

- [i] Single-beam bathymetric, magnetic and gravity characteristics across the axial ridge segments of the CIR along 4 lines of length of 440 km each in VM area,
- [ii] Single-beam bathymetric, magnetic and gravity characteristics of the fracture zones along 4 lines across FZs of length of 222 km each in the VM and VT areas,
- [iii] Geological sampling (rock & sediment) and water column samples from the RTI's, axial valleys, and fracture zones.

Bathymetric, gravity and magnetic data were collected to study the morphology and tectonics of the segments of the Central Indian Ridge and the fracture zone and to understand the spreading history of the ridge. Although five dredge operations were carried out for the recovery of rock samples, only two operations at the VT region yielded rock and other associated samples. Three stations were sampled for studying the chemistry of water column in VM and VT areas. Water samples were also collected for the analyses of calcium, magnesium, boron, total dissolved manganese and methane.

After the completion of all the operations, the ship arrived at Chennai Port on 25 August.

### 3. PARTICIPANTS

#### 3.1 Scientific component

Ranadhir Mukhopadhyay ( <i>Chief Scientist</i> )	)	
K.S.R. Murthy	)	
R. Banerjee	)	
M.M. Malleshwara Rao	)	
Sridhar D. Iyer	)	
A. Subrahmanyam	)	NIO, Goa
P.V. Shirodkar	)	
I. Ghose	)	
G.P. Naik	)	
P. Ganeshan	)	
A. Koteswara Rao	)	
A. Suribabu	)	
C. Ganesh	—	Ship Board Trainee
Shellak Davis	)	
P Boopathy	)	M/s NORINCO Pvt. Ltd., Goa
Benny J Panakal	)	
KM Jaikrishnan	)	

#### 3.2 Ship's Complement

Capt. W.T. Pereira	—	Master
Sam Abraham	—	Chief Officer
N.S. Bajwa	—	3rd Officer
V. Gurayya	—	AWKO
Ashwani Kumar	—	AWKO
James Jose	—	Med. Officer
G.S. Nagarcenkar	—	Radio Officer
G.C. Jacques	—	Purser
Vinay Kumar	—	C/E/O
V. Singh	—	2 EO
Ravi R. Rao	—	3 EO
M. Mondal	—	4 EO
Y.K. Bhusan	—	5 EO
Sreedharan P.	—	Elec. Officer
Vinay Kotnala	—	Elec. Officer
I.R. Vaz	—	Ctg. Officer
S. Karunakaran	—	Asst. Ctg. Officer

#### 4. THE BACKGROUND

The world's ocean ridge system (ORS), along which new crust forms, is a 70,000 km long underwater mountain range. Study of this ridge system, needless to add, is of immense importance as new oceanic crust is continuously generated with surfacing of hot molten lava along the length of the ridge.

Previous work in the Indian Ocean suggests that the Central Indian Ridge (CIR) is spreading at 46 cm/yr (full rate) and the ridge segments being deeply rifted in excess of 3.5 km. The offsets separating ridge segment are ~100 km along Vityaz Fracture Zone (area VT, relief 3050 m), 300 km along Vema Fracture zone (area VM, relief 4000m), 110 km along Argo Fracture Zone (area AR, relief 2800 m) and 210 km along Marie Celeste Fracture Zone (area MC, relief 4600 m). As noted world wide, fracture zones and transform faults could be high priority areas for georesearch. However, very little work has been carried out along the CIR, particularly at the ridge-transform fault intersection (RTI).

InRidge is the Indian initiative to carry out research along the Indian Ocean Ridge systems. This programme is founded recently and is accorded a corresponding membership of the International Agency, "InterRidge". It has also reference to the activities, the National Institute of Oceanography (NIO) has proposed in the IX plan for the Mid Oceanic Ridges in the Indian Ocean.

During the length of this programme, it is planned to make detailed tectonic and petrological studies in four areas - VT, VM, AR, MC - involving CIR segment disturbed by four prominent fracture zones, Vityaz, Vema, Argo and Marie Celeste, respectively.

#### 5. CRUISE DETAILS

Cruise 125 of ORV *Sagar Kanya* (InRidge-1) started on 25 July 1997 from Mormugao Port. The aim of the cruise was to study the Central Indian Ridge (CIR); as very little work has been carried out along the CIR, particularly at the Ridge-Transform fault Intersection (RTI). The offsets separating ridge segment are Vityaz Fracture Zone (VT), Vema Fracture Zone (VM), Argo Fracture Zone (AR) and Marie Celeste Fracture Zone (MC). It was planned to make detailed tectonic and petrological studies in these four areas. A number of locations were carefully selected for geological and hydrographic sampling. Single-beam bathymetric, magnetic and gravity characteristics were collected. A total of five dredge operations were carried out for rock and sediment samples i.e. three in the VM area and two in the VT region. Only the operations in the VT area yielded good haul of rock and other samples.

Three stations were sampled for studying the chemistry of water column in VM and VT areas. The sampling of water was carried out at standard depths ranging from 0-2000 m layer using CTD-rosette sampler. Various physico-chemical parameters were collected. Apart from this, water samples were collected for the analyses of some major elements such as calcium, magnesium, boron total dissolved manganese (TDM) and methane in regard to their geological importance.

After the completion of the operations the ship returned to Chennai Port on 25 August.



## 6. PRELIMINARY OBSERVATIONS

### a) Geophysical data

Preliminary and qualitative observations of bathymetry, magnetic and gravity data collected in the cruise (need to be refined after laboratory processing) reveal the following initial significant information:

- (i) In the study area VM, seabed depth varies from 1500 to as high as 6200 m. In general the depth is higher in the northeastern part in comparison to the southwestern part.
- (ii) Bathymetry sections in the area VM across the ridge segment suggest a steep axial valley having a width of nearly 15 km in the northeastern part of the area and another broad elevated topography in the southwestern part. These are separated by a broad valley whose topography is distinct in character in the two sections located on either side of the Vema Fracture Zone.
- (iii) Bathymetry sections across Vema Fracture Zone reveal a steep valley with a maximum depth of nearly 6000m (observed along section VMII), with relatively less steep valley northeast (VM I) and southwest of it. The width of Vema Fracture Zone is nearly 35 km across the section VMII. Minor valleys are also observed north and south of Vema Fracture Zone.
- (iv) Magnetic anomalies are in general subdued in nature over the fracture zones whereas the steep axial valley and elevated topography observed along the CIR sections are associated with anomaly amplitudes of few hundred nT. The axial valley observed in the CIRI bathymetry section appears to be a spreading ridge and preliminary observations indicate sea floor spreading anomalies upto 3 parallel to the ridge trend. One significant observation is that the anomalies are less conspicuous on the southwestern side of the axial valley than on the northeastern side.
- (v) Magnetic anomaly observed over the Central part of Vema Fracture Zone is not more than 200nT and it appears to be offset towards southeast.
- (vi) Freeair gravity anomalies over the ridge sections (CIR I and II) are subdued in nature, except those associated with the axial valley where freeair anomaly low of the order of 150mGal. This coincides with magnetic and bathymetry anomaly trends.
- (vii) Freeair gravity anomalies across the fracture zone sections (VM I and II) are variable in amplitude, with a maximum anomaly of 200 mGal recorded over the steepest part of the Vema fracture zone (VM II).
- (viii) Bathymetry, magnetic and gravity data were also collected over three seamounts near the area VT on the return journey from the study area. The relief of these seamounts is nearly 1100 1300m.

### b) Ridge rock samples

#### (i) Rocks from axial crest region in VT area:

A good haul of basaltic rocks was collected here. The haul includes seven large (10 cm length) pillow basalts weighing 64 kg, followed by 15 fragments with size between 510 cm weighing 15 kg, and many smaller fragments and glass chips (size cm, weight 1.1 kg). The largest pillow is about 42x35x31 cm and is heavily encrusted with ferromanganese oxides upto 3 cm thick. The oxide coating shows mamillated to honeycomb structure. Similar features are also noted in the other large boulders.

The basaltic glass on the samples vary in thickness between 0.5 to 5 cm and is mostly coated with FeMn oxides. The transition zone (i.e between the glass and the holocrystalline interior) is not very distinct as it merges with the underlying interior, thickness 13 cm). Stains of seawater alteration are present. On slicing few samples, the interior was found to be very fresh and phyric with abundant phenocrysts of fresh plagioclase.

*(ii) Rocks from RTI region of VT area:*

Dredging at this location was highly productive and the recovery was nearly 100%. Based on visual examination, the haul was subsampled into six types, which are described below:

**Ferromanganese coating over altered basalt glass:** This category of samples forms 85% of the total collection. The thickness of the oxide coating over the foliated glass is variable between 1.5 to 5 cm. Extensive FeMn coated bioturbation and burrow features are present.

**Calcareous clayey sand:** Such materials form 5% of the total recovery and vary in size from 1 cm to as large as 14x10 cm. The samples are buff white in colour and effervescence with HCl. These calcareous materials occur as substrate of FeMn oxides on glasstop and also occur below the basaltic glass.

**Red burnt materials :** Irregular slabs of redblack materials with abundant pores constitute about 1% of the total recovery. The smallest piece obtained was 2 cm and the largest measures upto 18x17x19 cm. On many of the slabs calcareous clayey sand and FeMn coating are present. Interestingly, these reddish 'burnt' materials have burrows as like those in calcareous clayey - ferromanganese coatings.

**Miscellaneous samples:** Few interesting samples with coralline features, 1 cm to 21 cm long with flat and tubular shapes, at times showing honeycomb features throughout, were found in the dredge haul. One of such fragments is encrusted with ferromanganese oxides.

**Manganese nodules:** Manganese nodules formed about 4% of the dredge recovery. The nodules of variable shapes, vary in size between 2 to 8 cm and rarely upto 10 cm. Nodules have one surface relatively smooth than the other. Many nodules have surficial patches of the calcareous materials. The nucleus of most of the nodules are hard volcanic rocks (basalts?) which at times contain phenocrysts of plagioclase.

**Hard rocks and glasses:** This category is very limited in their occurrence, and constitutes about 5% of the haul. Crystalline interior is poorly altered to variable degree. The ferromanganese coating is upto 3 cm and exhibit small botryoids. The basaltic glass shows little to high alterations.

In summary, the rocks from axial ridge area appear homogenous of fresh to moderately altered basalts with Fe-Mn encrustations. In contrast, samples from ridgetransform fault intersection [RTI] are of assorted types with basalts (altered to different degrees), calcareous materials (clayey sand, coralline), basaltic glass, manganese nodules and Fe-Mn encrustations. It would be interesting to determine the origin and the relationship of the rocks and the associated materials recovered in both of these dredges.

**c) Chemistry of water column**

Three stations were sampled for studying the chemistry of water column. Some salient observations are:

- (i) Significant variation in some parameters in the upper 200 m water column is noted. The lowest temperature in the upper 200 m in VM area is less than 26<sup>o</sup>C, whereas

that in VT area is higher than 27<sup>0</sup>C. However the lowest temperature along the water column in both the areas remains comparable (2.62.8<sup>0</sup>C).

- (ii) Salinity values suggest existence of two layers, i.e. high salinity (3535.3 psu) in upper 200 m, and lower salinity below that depth (34.6834.94 psu).
- (iii) The dissolved oxygen is high at the surface and gradually decreases till a minimum value is reached (oxygen minima) at 750 m. Further down it increases again.
- (iv) pH in general decreases with depth 8.08.3 at the surface and 7.8 at about 1900 m depth.

## 7. RECOMMENDATIONS

- (i) About 2/3 rd of the cruise days have gone towards unproductive travelling, and only 08% of the cruise time was available for sampling. This is not healthy both from economic and academic point of view, and need to be rectified. Even this distribution of time was possible after a change was made to operate at VM and VT areas rather than a distant AR and MC areas. It may be ensured that, henceforth, InRidge cruises may be started from and/or finished at a nearby port, such as Port Louis, Mahe or Male.
- (ii) The results of this cruise were, to some extent, depleted with the nonoperation of multibeam bathymetry system. To make matter worse, the deep sea winch did not work on the last working day, forcing us to abandon two stations. Ship instrumentation needs to be looked into in a more systematic and coordinated manner to avoid any such fall outs in future.

## 8. ACKNOWLEDGEMENTS

The Chief Scientist and other participants of InRidge-I cruise of ORV *Sagar Kanya* are grateful to the United States India Fund for (assured) funding and the Department of Ocean Development, New Delhi for making available the ship. We also thank the Captain and other officers of the ship for their assistance and cooperation during the cruise.

**Table 1 :** Summary of underway geophysical data collection and geological and hydrographic sampling

**A - Geophysical data collection (bathymetry on ELAC echosounder, Magnetics on EG&G-G886, and Gravity on Bodenseewerk KSS-30) :**

Tectonic setting	Trend	Latitude	Longitude	Number of Lines	Length (km)
<u>Area VM</u>					
Across CIR	NE-SW	07 -12°S	65 - 69°E	Four	1587
Across Vema FZ	NW-SE	07 -12°S	65 - 69°E	Four	0924
Transit Lines	NE-SW	07 -12°S	65 - 69°E	Three	0341
<u>Area VT</u>					
Across Vityaz FZ & seamounts	NNE-SSW	05 -08°S	67°30'E	One	0333

**B - Geological & Hydrographic sampling**

Tectonic Setting	Latitude (S)	Longitude (E)	Depth (m)	Station number	Operation type	Success
<u>Area VM</u>						
On FZ	11°19.0	66°20.2	3450	1	Dredge	No
On RT I	10°54.6	66°25.6	2300	2	Dredge	No
Ridge crest	10°41.5	66°22.1	2400	3	Water Dredge	Yes No
<u>Area VT</u>						
Axial valley	05°39.6	68°03.8	3050	4	Water Dredge	Yes Yes
On RT10	5°35.2	67°54.9	3560	5	Dredge	Yes
On FZ	05°38.8	67°32.4	4020	6	Water	Yes

**Note :** RTI = Ridge Transform fault intersection, FZ = Fracture Zone  
 VT area = CIR area segmented in and around Vityaz fracture zone  
 VM area = CIR area segmented in and around Vema fracture zone