Report on Oceanographic Cruise of O. R. V. Sagar Kanya

CRUISE No. 47

28th November to 22nd December, 1988

National Institute of Oceanography
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INDIA

NATIONAL INSTITUTE OF OCEANOGRAPHY
(Council of Scientific & Industrial Research)

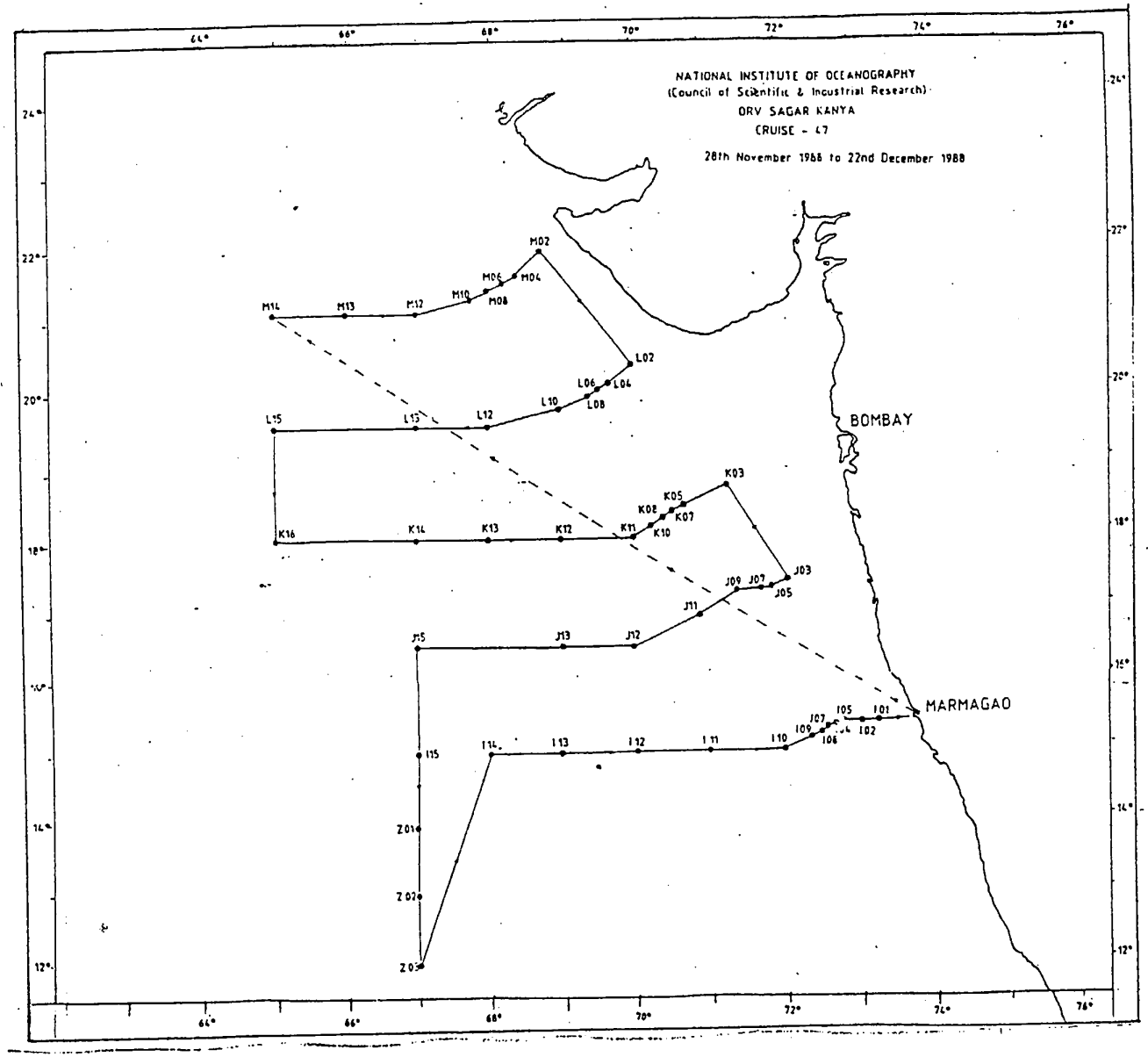
REPORT ON

47TH OCEANOGRAPHIC CRUISE OF

O.R.V. SAGAR KANYA

(28 November to 22 December, 1988)

CONTENTS


NATIONAL INSTITUTE OF OCEANOGRAPHY
(Council of Scientific & Industrial Research)
ORV SAGAR KANYA
CRUISE - 47
28th November 1988 to 22nd December 1988
BOMBAY
MARMAGAO
M02
M04
M06
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2. CRUISE SUMMARY

The 47th cruise of ORV Sagar Kanya was planned to study the coastal circulation and some biogeochemical processes within the oxygen-deficient zone of the northern Arabian Sea using several tracers including radionucleides. The cruise was of 24 days duration, starting from and ending at Mormugao.

During the cruise a total of 50 stations were occupied for routine hydrographic and hydrochemical observations: 16 for nitrous oxide analysis, attempted successfully for the first time; 16 for ETS (electron transport system) activity measurements, again a maiden effort; and three deep profiles for some radioactive constituents. In addition, four box cores were collected for porewater profiling of nutrients, trace metals and for radiochemical investigations; 14 samples of surficial sediments were taken for biochemical analysis; and at 38 stations, observations were made on chemical composition of sea surface microlayer (SML).

All the objectives of the cruise were achieved.

3. PARTICIPANTS

a) Scientific component

Dr. S.W.A. Naqvi	)	Chief Scientist
Mr. M. Manoharan	)	
Mr. M.D. George	)	
Dr. M. Dileep Kumar	)	
Dr. P.V. Narvekar	)	Chemical Oceanography Division
Dr. (Ms) M.S. Shailaja	)	N.I.O. Goa.
Ms A. Rao	)	
Mr. K. Somasundar	)	
Mr. Blasco Fernandes	)	
Mr. R.J. Noronha	)	
Ms M. Nair	)	
Mr. A.D. Gouveia	)	Physical Oceanography Division
Mr. G. Namboodri	)	N.I.O. Goa.
Mr. Raja Raman	)	Geological Oceanography Division
	)	N.I.O. Goa
Prof. B.L.K. Somayajulu	)	
Dr. M.M. Sarin	)	Physical Research Laboratory
Dr. A.R. Pandian	)	Ahmedabad.
Mr. Ravi Bhusan	)	

b) Ship's Complement

Capt M.S.L. Fernandes	Master
Mr. C. Carneiro	Chief Officer
Mr. S.J. Shekhadkar	Second Officer
Mr. S.D. Warke	Chief Radio Officer
Mr. N.K. Chattoraj	Radio Officer
Dr. S. Gokulnath	Medical Officer
Mr. R.C.S. D'Silva	Purser
Mr. R.V. Lad	Chief Engineer
Mr. Arun Ajmani	Second Engineer
Mr. T. Dasgupta	Fourth Engineer
Mr. A. D. Choudhury	Fifth Engineer
Mr. M.S. Malhan	Fifth Engineer
Mr. B.K. Vashishat	Electrical Officer
Mr. B.N Mistry	Electrical Officer

4. OBJECTIVES

1. To collect additional data for understanding coastal circulation.

2. To determine the rate of water-column denitrification from measurements of the activity of electron transport system (ETS).

3. To study dissolved nitrous oxide distribution in the Arabian Sea for understanding its fate and flux across the air-sea interface.

4. To study the processes affecting iron, chromium and vanadium in the water column and near sediment-water interface.

5. To determine porewater profiles of nutrients and selected trace metals.

6. To study the chemistry of sea surface microlayer.

7. To study the fate of reactive elements in oceanic areas of distinctly different properties.

5.CRUISE DETAILS

The vessel sailed from Mormugao on 28th November and returned to the same port on 22nd December 1988.

Standard hydrocast sampling covering the entire water column was done at all but one station using reversing samplers (TPN Hydrobios or metallic Nansen) equipped with thermometers to record the temperature. Analyses for salinity, dissolved oxygen and nutrients (phosphate, nitrate, nitrite and silicate) were performed on board the ship. A Guildline salinometer was used for salinity measurements; the Winkler procedure was followed for dissolved oxygen estimations and nutrients analyses were made using a Skalar 6-channel Analyzer.

Samples for N_2O measurements were collected from a separate cast using either the TPN (reversing) bottles or 5 liter Nisken samplers. A total of 16 stations were occupied for nitrous oxide measurements along a zonal (Leg X) and a long meridional (67^{o} E) transects. In most cases, the entire water column was covered. Subsamples taken in ground glass stoppered bottles (ca 1.2 l) were analysed on board ship within a few hours of collection using a Perkin Elmer 3920B Gas Chromatograph.

120 samples were collected at 10 locations for trace metals analyses using 5 l Niskin samplers mounted on a PVC-coated hydrowire. Preconcentration was done through

coprecipitation, and the acid dissolved samples were brought to the shore laboratory for AAS analyses.

ETS activity measurements were made at 16 stations. Usually four depths were sampled at each site, based on previously determined nitrite profile, and 5 to 10 liters of the sample was filtered.

Extensive observations were made on the chemistry of the sea-surface microlayer (SML). Concentrations of nutrients as well as some elements of crustal origin (aluminium and arsenic) were determined within the SML, at various depths.

Four box cores (length ca. 30 cm) were collected from different depth regimes underlying oxic as well as reducing waters. Segments of the subcores were pressure-squeezed using nitrogen gas , and the interstitial water samples so obtained were analysed for nutrients including ammonia. A part of the sample was also preserved for trace metal analysis in the shore laboratory.

Aerosol samplings were also carried out in between stations for subsequent analyses in the shore laboratory in order to determine the atmospheric inputs.

Sediment samples were collected at 15 stations to study the distribution of some biochemical compounds in the surficial sediments of the Arabian Sea.

At 4 locations (between 15°N and 21°N) in the Arabian Sea, vertical profiles of 30 L water samples were collected in PVC Niskin Samplers, filtered whenever needed and processed on board the Ship for $^{238,234}U$, $^{234,228}Th$, ^{210}Pb, ^{210}Po, $^{228,226}Ra$ isotopes. From at least two of the locations, spade cores (ca. 30 cm in length) were collected and sampled to see if any imprint of the productivity controlled radioisotope systematics could be seen in the sediments representing the Holocene (past ca. 10^4 years).

Thirty-one 50 ml samples were collected for stable isotope (of oxygen) measurements which are being made. This is part of a large programme to determine oxygen isotopic variations (seasonal, annual etc.) in different parts of the Indian Ocean.

About 15 to 20 samples (a few in 100 l GO-FLO Bottles) were also collected for measuring $^{228,226}Ra$ and tritium to study mixing in the near-surface waters in certain near-coastal regions of the Arabian Sea. The measurements have just began and it would take a year to complete them.

On board seminars

Several informal gatherings were organised wherein scientists from both PRL and NIO presented their work. These seminars generated enormous interest and it is recommended that these should form an essential part of all future cruises.

6. SYNOPSIS OF OBSERVATIONS AND DATA COLLECTION

In all 50 stations were worked during the cruise. The synopsis of all observations made, work schedule and station locations is given in Annex - 1.

7. SIGNIFICANT FINDINGS

Several new investigations were initiated during the cruise.

Detailed analyses of large amount of data and samples are in progress. Preliminary analysis, however, reveals several interesting features:

1. Surface N_2O concentrations are several fold higher than the saturation values suggesting that the Arabian Sea could be a significant source of atmospheric N_2O. Consistent with the observations in other oxygen-poor environments, there appears to be a net consumption of N_2O (< 10 nM) within the denitrifying layer and enhanced production (>40 nM) at its boundaries.
2. ETS based denitrification rates compare very well with recent box model calculations based on the exports of nitrate deficits from the denitrification zone leading to a high rate of denitrification for the Arabian Sea.

3. Ammonia levels in porewaters of the sediment in contact with the oxygen-minimum layer were exceedingly high (>500 uM).

4. Trends of distribution of most of the constituents and their enrichment in SML were similar to previous observations made in the same area, but the observed levels (< 10µg/l) and enrichment factor (< 1) of aluminium in SML were markedly lower during the cruise. Total arsenic (As^{+5} and As^{+3}) was mostly depleted in SML relative to the subsurface water.

8. ACKNOWLEDGEMENTS

All the participants express their gratitude to the Master, Chief Engineer and all officers and crew for their support and co-operation. The cruise provided an excellent example of an inter-laboratory collaboration. The Chief Scientist and all other participants from NIO record their thanks to Prof. B.L.K. Somayajulu for his guidance and for keeping them in good humour throughout the cruise. It was due to his promptings and interest that we were able to organise several scientific seminars during the cruise.

ANNEX 1.

PERFORMANCE CHART AND SYNOPSIS OF OBSERVATIONS

O.R.V. SAGAR KANYA CRUISE # 47.

STN NO	LATITUDE (N)	LONGITUTE (E)	ARRIVAL DATE	ARRIVAL TIME	DEP DATE	DEP TIME	DEPTH MTS	HYDRO CAST	TR-ME N20	RADIO CHEM	COREP	GRAB	ETS	SSML	AS/AL	RAD BAG	NEAR BOT	HC	N-NET
M14	21 00.15	65 00.19	11/30/88	23.30	12/01/88	04.30	2560	XX					XX	XX	XX	XX			
M13	20 59.78	66 00.10	12/01/88	11.25	12/01/88	16.20	2514	XX					XX	XX	XX				
M12	20 59.90	67 00.05	12/01/88	23.00	12/02/88	19.20	2410	XX	XX	XX	XX		XX	XX	XX	XX			
M10	21 12.89	67 47.17	12/03/88	01.05	12/03/88	04.30	2060	XX						XX	XX				
M08	21 20.00	68 03.00	12/03/88	06.55	12/03/88	09.20	0320	XX				XX	XX	XX	XX		XX		
M06	21 25.99	68 13.11	12/03/88	10.55	12/03/88	12.15	0154	XX				XX		XX	XX	XX			
M04	21 31.26	68 24.10	12/03/88	14.10	12/03/88	15.15	0097	XX				XX		XX	XX	XX			
M02	21 52.42	68 47.66	12/03/88	18.50	12/03/88	22.10	0058	XX				XX		XX	XX				
L02	20 20.01	70 03.00	12/04/88	06.30	12/04/88	07.25	0080	XX				XX		XX	XX				
L04	20 05.10	69 38.84	12/04/88	10.40	12/04/88	11.48	0080	XX				XX		XX	XX	XX			
L06	20 00.36	69 32.16	12/04/88	12.40	12/04/88	13.36	0113	XX				XX		XX	XX			XX	
L08	19 54.32	69 23.62	12/04/88	15.00	12/04/88	19.40	0375	XX		XX	XX		XX	XX	XX	XX			
L10	19 44.30	69 01.86	12/04/88	10.30	12/04/88	17.10	2425	XX						XX	XX	XX		XX	
L12	19 30.04	67 59.87	12/05/88	08.50	12/05/88	14.20	3200	XX						XX	XX	XX			
L13	19 30.00	67 00.00	12/05/88	20.40	12/06/88	04.00	3000	XX	XX				XX	XX	XX	XX		XX	
L15	19 29.95	65 00.30	12/06/88	16.30	12/06/88	23.45	3105	XX					XX	XX	XX	XX		XX	XX
K16	17 59.93	65 00.38	12/07/88	09.50	12/07/88	14.00	3402	XX	XX				XX	XX	XX	XX			
K14	18 00.10	67 00.09	12/08/88	08.20	12/08/88	17.30	3423	XX	XX	XX			XX	XX	XX	XX		XX	XX
K13	17 59.79	67 59.27	12/09/88	00.20	12/09/88	08.00	3415	XX	XX	XX				XX	XX	XX			
K12	18 00.01	69 00.02	12/09/88	14.45	12/10/88	22.20	3359	XX	XX				XX	XX	XX	XX		XX	XX
K11	18 00.17	69 59.71	12/10/88	04.45	12/10/88	22.20	2641	XX	XX	XX	XX		XX	XX	XX	XX			
K10	18 08.08	70 12.07	12/11/88	00.10	12/11/88	03.30	2262	XX						XX	XX	XX			
K08	18 16.09	70 25.00	12/11/88	05.40	12/11/88	11.00	1025	XX	XX					XX	XX	XX			
K07	18 19.79	70 32.97	12/11/88	12.30	12/11/88	15.10	0210	XX	XX			XX				XX			XX
K05	18 23.85	70 40.82	12/11/88	16.40	12/11/88	17.25	0085	XX	XX			XX							
K03	18 42.16	71 16.21	12/11/88	22.10	12/11/88	23.10	0080	XX				XX		XX	XX	XX			XX
J03	17 23.96	72 07.96	12/12/88	09.25	12/12/88	10.05	0095	XX				XX		XX	XX				
J05	17 17.98	71 52.97	12/12/88	11.55	12/12/88	12.35	0095	XX				XX		XX					
J07	17 16.00	71 46.60	12/12/88	14.00	12/12/88	18.00	0340	XX		XX	XX			XX	XX	XX			
J09	17 09.28	71 25.92	12/12/88	20.10	12/12/88	22.55	1537	XX					XX	XX	XX	XX			
J11	16 57.07	70 55.23	12/13/88	03.25	12/13/88	07.00	2685	XX						XX	XX	XX			
J12	16 30.06	69 59.98	12/14/88	14.00	12/13/88	19.00	3620	XX						XX	XX	XX		XX	
J13	16 29.99	68 59.95	12/14/88	01.35	12/14/88	07.00	3643	XX					XX	XX	XX	XX		XX	
J15	16 29.57	67 00.76	12/14/88	19.25	12/15/88	05.30	3686	XX	XX	XX			XX	XX	XX	XX		XX	
I15	15 00.70	66 59.82	12/15/88	15.40	12/16/88	18.30	3939	XX	XX	XX	XX			XX	XX	XX		XX	
Z01	14 00.09	67 00.05	12/17/88	01.00	12/17/88	06.35	4024	XX	XX				XX	XX	XX	XX		XX	
Z02	13 00.14	67 00.03	12/17/88	13.00	12/17/88	16.00	4092	XX	XX						XX	XX			
Z03	11 59.87	66 59.70	12/18/88	02.00	12/18/88	09.00	4207	XX	XX					XX	XX	XX			
I14	14 59.96	67 59.94	12/19/88	07.00	12/19/88	14.05	3926	XX	XX	XX			XX	XX	XX	XX		XX	
I13	15 00.62	69 00.05	12/19/88	21.50	12/20/88	01.50	3659	XX										XX	
I12	15 00.08	69 59.95	12/20/88	09.18	12/20/88	15.00	3448	XX						XX	XX	XX			XX
I11	14 59.08	71 00.00	12/20/88	21.05	12/21/88	00.20	2596	XX								XX			
I10	15 00.00	71 59.99	12/21/88	06.20	12/21/88	16.00	2051	XX			XX			XX		XX			
I09	15 08.01	72 23.78	12/21/88	19.12	12/21/88	21.00	1778	XX								XX			
I08	15 12.04	72 32.96	12/21/88	23.33	12/22/88	01.00	1411	XX								XX			
I07	15 15.97	72 41.01	12/22/88	03.15	12/22/88	06.30	0933	XX			XX					XX			
I06	15 18.23	72 45.55	12/22/88	07.20	12/22/88	08.50	0739	XX								XX			
I05	15 22.01	72 49.93	12/22/88	10.05	12/22/88	11.45	0284	XX			XX								
I02	15 22.98	73 06.85	12/22/88	14.42	12/22/88	15.42	0096	XX				XX							
I01	15 23.06	73 18.00	12/22/88	16.30	12/22/88	16.45	0069					XX							