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

CRUISE No. 63

12th March to 12th April 1991

National Institute of Oceanography
Dona Paula–403 004, Goa
INDIA

NATIONAL INSTITUTE OF OCEANOGRAPHY
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REPORT ON

63RD OCEANOGRAPHIC CRUISE OF

O.R.V. SAGAR KANYA

(12 March to 12 April, 1991)

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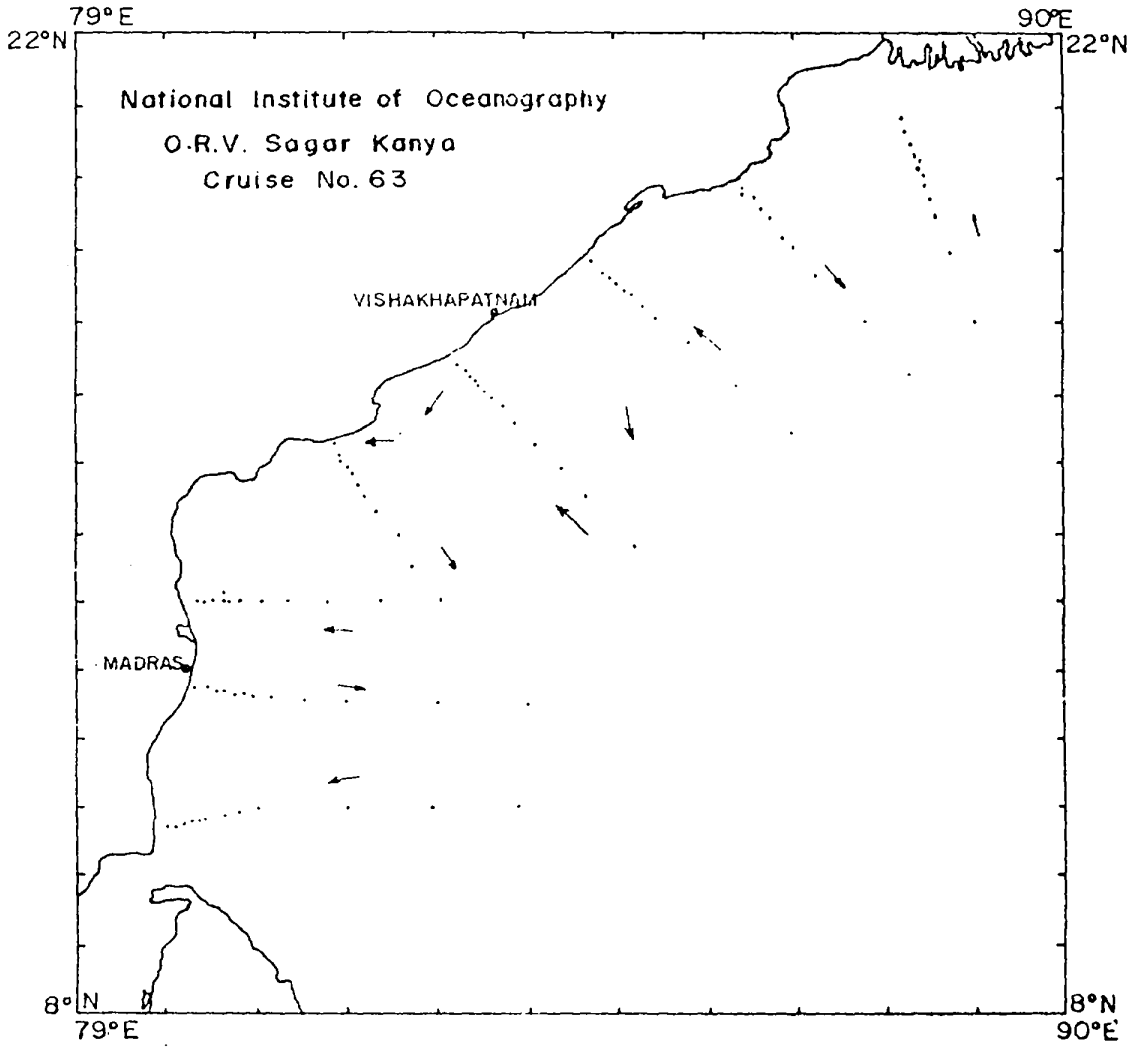
CONTENTS

2. CRUISE TRACK AND STATIONS



2. CRUISE SUMMARY

ORV Sagar Kanya sailed from Madras harbour on 12 March, 1991 and returned to Mormugao on 12 April, 1991. One port call was made at Visakhapatnam during 26-27 March for taking fresh water. The area of operation during the cruise was off the east coast of India. Observations were made to study the biological, chemical and physical oceanography of the coastal region. Approximately 4250 nautical miles were logged during the cruise and 91 oceanographic stations were worked on. At each station CTD casts were used to determine vertical profiles of salinity and temperature. Water samples were collected, either by using a rosette or with hydrocasts, to measure concentrations of nutrients and of dissolved oxygen (64 stations), nitrous oxide (28 stations), carbon dioxide (30 stations), and atmospheric/sea surface carbon dioxide and nitrous oxide (54 stations). Sampling for phytoplankton studies was carried out at 61 stations. Water samples to carry out radioisotope analyses were collected at 36 stations for near surface studies and at 4 stations for vertical profiles through the vertical column.

3. PARTICIPANTS

(a) Scientific Component

Satish R. Shetye	- Chief Scientist
Albert D. Gouveia	Physical Oceanography Division
S.S.C. Shenoi	
G. Nampoothiri	
D. Sundar	
G.S. Michael	
S.W.A. Naqvi	Chemical Oceanography Division
M.D. George	
M. Dileepkumar	
D. Amal Jayakumar	
Maheshwari Nair	
P.V.S.S.D.P. Rao	
M. Manoharan	
S. Banerjee	
Joaquim Goes	Biological Oceanography Division
Helga Gomes	
M.M. Sarin	Physical Research Laboratory, Ahmedabad
M. Rengarajan	
R. Ramesh	
D.N. Yadav	
C. Ravi	Trainees
Vijay Kumar	
U.B. Promod Kumar	
Niju Paul	
Ganesh M. Chandvale	
M.M. Subramaniam	
K. Muralitharan	

(b) Ship's Complement

R.D. Sudarshan	-	Captain
H.N. Shewale	-	Chief Engineer
K.K. Garg	-	Chief Officer
M. Satishkumar	-	A.W.K.O.
O.J. Sheby	-	T.N.O.
M. Fernandes	-	Catering Officer

4. OBJECTIVES OF THE CRUISE

The objectives behind each component of the oceanographic data collection during the cruise are described below.

4.1 Biological Oceanography

With the aim to assess the living resources in the area, phytoplankton biomass and primary productivity studies were undertaken in the euphotic zone. In addition, dark carbon dioxide fixation was measured below the euphotic zone. The above studies also included chlorophyll and euphotic zone primary production estimates of the picoplankton (less than 1 micron) fraction. Concomitant with these studies, the underwater light field was measured using a Licor quantum sensor. Vertical profiles of chlorophyll, which enabled location of the deep chlorophyll maximum were established using an in-situ continuous profiling fluorometer. These data will help to improve algorithms for estimating chlorophyll from satellite data in the tropics. Photosynthesis versus irradiance studies were undertaken, with samples of Trichodesmium, which was observed as a bloom at some stations. Zooplankton-phytoplankton interactions in the region were studied by measuring their grazing and gut evacuation rates. Samples for estimating bacteria using epifluorescene microscopy were collected for later analysis on shore.

4.2 Chemical Oceanography

The main thrust in chemical oceanography was to determine the depth profiles of nitrous oxide (N_2O) and of dissolved inorganic carbon to quantify the fluxes of N_2O and carbon dioxide across the air-sea interface. Detailed profiles were generated along legs B, E, G and H as well as at the extreme offshore stations of the other legs. Measurements of nitrous oxide and carbon dioxide levels in surface seawater were coupled with the analyses of the air samples for the purpose of flux estimation at most of the stations. Data on nutrients and dissolved oxygen were also collected at almost all the stations. In addition, water samples were also collected and stored for the analysis of aluminium in the shore laboratory, as were the aerosol samples collected while the ship was underway between the sampling stations.

Dissolved oxygen was determined titrimetrically. The analyses for nutrients (nitrate, nitrite and silicate) were performed with a SKALAR analyzer. Phosphate was estimated manually. Total CO_2 concentrations were determined using a coulometer while the pH was measured with an Orion Research pH meter (model 701 A) using NBS buffers. Nitrous oxide measurements were made using a Perkin-Elmer 3920B gas chromatograph.

4.3 Physical Oceanography

The objective of the physical oceanographic studies was to collect hydrographic data to determine the large-scale circulation along the east coast of India. Altogether 91 stations, distributed in 8 legs, were worked on. The distance between two consecutive stations in a leg was of the order of 10 km in the vicinity of the shelf break, increasing away from the shelf to about 100 km in the open sea. At each station vertical profiles of temperature and salinity were determined using the onboard CTD system, SeaBird SBE9.

4.4 Radio Isotope Studies

About 20-30 l of sea water samples were collected at depths ranging between 0 to 3000 m. In all about 45 samples were collected at four stations, A12, E13, F11 and H13. These samples were processed on board to concentrate the short and long lived radionuclides ^{234}Th, ^{210}Po, ^{210}Pb, ^{226}Ra and ^{238}U. The vertical distribution of these radionuclides will help to understand the chemical removal processes associated with the settling of particles through the water column. Using simple box-model calculations it is possible to predict the fate of reactive elements in sea water and their removal residence time in sea water. A number of surface water samples were collected to study

the lateral distribution of radium isotopes, ^{228}Ra and ^{226}Ra, as a function of distance from the coast. This study will provide information on the horizontal advective transport processes.

Surface water samples (approximately 30 ml) were collected along the cruise track for stable oxygen isotope measurements. This is to establish the salinity-oxygen isotope relationship in the Bay of Bengal, which will help in the interpretation of paleo-oxygen isotope data.

5. CRUISE DETAILS

Station locations and the type of data collected at each of the stations are listed in the Annexure. The code used in the Table there is as follows:

TS : CTD Profiles from surface to bottom

NT : Nutrients and oxygen

NC : Nitrous oxide and carbon dioxide

AN : Atmospheric and sea surface carbon dioxide and nitrous oxide.

PT : Phytoplankton concentrations.

RI : Radio Isotope studies: vertical profiles or surface measurements.

6. SYNOPSIS OF OBSERVATIONS

The data collected during the cruise provide a comprehensive look of the large scale oceanography of the region off the east coast of India during March-April. The data would be helpful in bringing out the structure of the circulation in the region, and in identifying its impact on the biology and chemistry of the region. The radio isotope studies would provide clues on the rates of horizontal and vertical mixing, which are important parameters that determine the water mass characteristics of the region.

7. PERFORMANCE OF ONBOARD EQUIPMENT

In general, the onboard equipment performed satisfactorily, except for the displays on the hydrographic and CTD winches. This made it difficult and risky to sample at depths.

8. ACKNOWLEDGEMENTS

The Chief Scientist and his colleagues are grateful to the Master, Officers and crew members for their cooperation during the cruise.

ANNEXURE

LOGGING OF OBSERVATIONS

ORV SAGAR KANYA CRUISE 6J

Sl No	Station Number	Location Lat	Location Long	Date	Time (IST(Hrs)	Depth (M)	Observations (see Sec. 5) TS	NT	NC	AN	PT	RI
1	63H13	17 59.60	88 59.90	14.3.91	0930-0300	2165	*	*	*	*	*	*
2	63H12	18 57.00	88 44.00	15.3.91	0424-1330	1870	*	*	*	*	*	*
3	63H11	19 28.90	88 35.30	15.3.91	1712-1930	1700	*					*
4	63H10	19 43.60	88 30.40	15.3.91	2132-0030	1550	*	*	*		*	
5	63H09	19 54.60	88 28.40	16.3.91	0315-0424	1340	*					*
6	63H08	20 02.10	88 26.60	16.3.91	0600-0752	1200	*	*	*		*	
7	63H07	20 08.40	88 23.50	16.3.91	0954-1315	1010	*					*
8	63H06	20 13.91	88 23.50	16.3.91	1512-1632	640	*	*	*	*	*	
9	63H05	20 19.60	88 21.50	16.3.91	1749-1809	180	*	*			*	*
10	63H04	20 26.60	88 18.10	16.3.91	1930-2114	126	*					*
11	63H03	20 37.30	88 14.90	16.3.91	2230-2300	105	*	*	*	*	*	*
12	63H02	20 49.00	88 12.20	17.3.91	0030-0126	63	*	*			*	*
13	63G01	19 50.80	86 26.20	17.3.91	1410-1445	41	*	*	*	*	*	*
14	63G02	19 45.50	86 27.00	17.3.91	1620-1830	87	*	*	*		*	
15	63G03	19 42.36	86 34.00	17.3.91	2003-2145	630	*	*	*	*	*	*
16	63G05	19 33.10	86 37.90	17.3.91	2320-0150	1190	*	*	*		*	
17	63G06	19 26.50	86 43.30	18.3.91	0312-0348	1460	*					
18	63G07	19 13.10	86 51.60	18.3.91	0620-0940	1725	*	*	*	*	*	
19	63G08	19 03.10	86 59.60	18.3.91	1130-1418	1925	*					*
20	63G09	19 41.00	87 15.30	18.3.91	1715-2100	2250	*	*	*	*	*	*
21	63G10	18 00.20	87 47.30	19.3.91	0230-0635	2250	*	*	*	*	*	
22	63G11	17 15.60	88 17.40	19.3.91	1048-1348	2460	*	*	*	*	*	*
23	63F11	16 27.14	88 56.85	19.3.91	2238-1115	2640	*	*	*	*	*	*
24	63F10	17 05.89	86 21.52	20.3.91	1800-2141	2600	*	*		*	*	*
25	63F09	17 42.48	85 48.85	21.3.91	0400-0845	2450	*	*		*	*	
26	63F08	18 02.50	85 26.90	21.3.91	1315-1515	2400	*					
27	63F07	18 13.13	85 18.74	21.3.91	1745-2200	2350	*	*		*	*	*
28	63F06	18 26.55	85 11.63	22.3.91	0040-0206	2200	*					
29	63F05	18 27.71	85 06.48	22.3.91	0345-0625	1460	*	*		*	*	*
30	63F04	18 32.10	85 01.46	22.3.91	0808-0901	700	*	*		*	*	
31	63F03	18 36.60	84 57.30	22.3.91	1020-1230	210	*	*			*	*
32	63F02	18 41.15	84 51.69	22.3.91	1340-1515	110	*	*		*	*	
33	63F01	18 50.59	84 43.37	22.3.91	1645-1809	45	*	*			*	*
34	63E13	14 47.92	85 12.60	23.3.91	1630-0040	3010	*	*	*	*	*	*
35	63E12	15 32.64	84 39.21	24.3.91	1120-1615	2980	*	*	*	*	*	
36	63E11	15 55.46	84 22.67	24.3.91	1845-2040	2990	*					*
37	63E10	16 16.40	84 06.10	24.3.91	2320-0306	3025	*	*	*	*	*	
38	63E09	16 34.73	83 52.81	25.3.91	0541-0755	1975	*					
39	63E08	16 50.79	83 44.33	25.3.91	0945-1305	2680	*	*	*	*	*	*
40	63E07	16 56.37	83 36.13	25.3.91	1500-1730	2658	*					
41	63E06	17 02.64	83 41.37	25.3.91	1850-2130	2400	*	*	*	*	*	
42	63E05	17 06.40	83 27.50	25.3.91	2210-2355	960	*					
43	63E04	17 11.04	83 24.57	26.3.91	0100-0147	71	*	*	*	*	*	
44	63E03	17 12.93	83 22.95	26.3.91	0240-0335	165	*					
45	63E02	17 17.62	83 19.91	26.3.91	0450-0545	95	*	*	*	*	*	
46	63E01	17 24.67	83 14.80	26.3.91	0705-0730	65	*					*
47	63D01	16 14.90	81 52.82	28.3.91	0900-0950	25	*	*			*	*
48	63D02	16 06.91	81 55.36	28.3.91	1124-1335	300	*	*		*	*	
49	63D03	16 01.70	81 56.62	28.3.91	1445-1605	840	*					

Sl No	Station Number	Location Lat	Location Long	Date	Time IST(Hrs)	Depth (M)	Observations (see Sec. 5) TS	NT	NC	AN	PT	RI
50	63D04	15 55.16	82 01.08	28.3.91	1730-1855	1180	*	*		*	*	
51	63D05	15 49.95	82 04.06	28.3.91	1949-2140	1350	*				*	
52	63D06	15 42.00	82 08.23	28.3.91	2320-0100	2070	*	*		*	*	
53	63D07	15 31.69	82 12.51	29.3.91	0245-0517	2480	*					
54	63D08	15 20.10	82 20.55	29.3.91	0715-1026	2780	*	*		*	*	*
55	63D09	14 56.07	82 35.08	29.3.91	1300-1600	3050	*	*		*	*	
56	63D10	14 29.95	82 44.31	29.3.91	1850-2120	3232	*	*		*		*
57	63C12	14 00.17	83 01.61	30.3.91	0130-0540	3280	*	*	*	*	*	
58	63C11	13 59.95	82 23.18	30.3.91	0948-1328	3305	*	*		*	*	
59	63C10	14 00.60	81 48.21	30.3.91	1800-2200	3280	*	*		*	*	*
60	63C09	14 00.32	81 20.09	31.3.91	0200-0600	3180	*	*		*	*	
61	63C08	14 00.15	81 03.79	31.3.91	0920-1140	3110	*					
62	63C07	14 01.60	80 50.08	31.3.91	1425-1745	2950	*	*		*	*	
63	63C06	14 00.67	80 42.14	31.3.91	2050-2225	2850	*					
64	63C05	14 01.34	80 37.21	1.4.91	0014-0315	2400	*	*		*	*	
65	63C04	14 00.64	80 31.06	1.4.91	0645-0730	1400	*					
66	63C03	14 00.43	80 25.61	1.4.91	0854-0930	180	*	*		*	*	
67	63C02	14 00.48	80 20.58	1.4.91	1155-1225	38	*	*		*	*	*
68	63B01	12 43.05	80 18.66	2.4.91	0125-0224	40	*	*	*	*	*	*
69	63B02	12.42.84	80 28.58	2.4.91	0400-0445	73	*	*	*	*	*	
70	63B03	12 41.79	80 33.73	2.4.91	0615-0625	90	*					
71	63B04	12 40.47	80 39.43	2.4.91	0745-0910	160	*	*	*	*	*	
72	63B05	12 39.71	80 44.95	2.4.91	1024-1140	1200	*					
73	63B06	12 38.86	80 50.94	2.4.91	1305-1615	3100	*	*	*	*	*	
74	63B07	12 37.05	80 58.28	2.4.91	1820-1955	3300	*					
75	63B08	12 36.51	80 10.18	2.4.91	2142-0146	3390	*	*	*	*	*	
76	63B09	12 35.15	81 31.56	2.4.91	0500-0625	3455	*					
77	63B10	12 30.37	81 59.46	3.4.91	0948-1353	3450	*	*	*	*	*	*
78	63B11	12 29.86	83 00.31	3.4.91	2022-2335	3390	*	*	*	*	*	
79	63B12	12 29.43	84 00.33	4.4.91	0532-1000	3355	*	*	*	*	*	*
80	63A12	10 59.67	83 54.09	4.4.91	1825-1206	3500	*	*	*	*	*	*
81	63A11	10 59.83	82 56.66	5.4.91	1835-2136	3540	*	*	*	*	*	*
82	63A10	10 59.62	81 59.49	6.4.91	0300-0530	3590	*	*		*	*	*
83	63A09	11 00.36	81 00.32	6.4.91	1048-1346	3360	*	*		*	*	
84	63A08	10 55.35	80 47.56	6.4.91	1545-1723	2920	*					
85	63A07	10 52.00	80 36.97	6.4.91	1900-2120	1340	*	*		*	*	
86	63A06	10 49.28	80 24.68	6.4.91	2245-2317	624	*					
87	63A05	10 47.90	80 20.84	7.4.91	0015-0140	370	*	*		*	*	*
88	63A04	10 46.64	80 17.76	7.4.91	0245-0303	252	*					
89	63A03	10 45.40	80 12.25	7.4.91	0410-0530	118	*	*		*	*	
90	63A02	10 42.82	80 06.18	7.4.91	0650-0730	45	*	*		*	*	
91	63A01	10 40.95	80 01.03	7.4.91	0826-0921	23	*	*		*	*	*