

CRUISE REPORT

ORV SAGAR KANYA

Cruise No. 120

December, 1996 - 31 January, 1997)



राष्ट्रीय समुद्र विज्ञान
संस्थान

NATIONAL INSTITUTE
OF
OCEANOGRAPHY

ORV SAGAR KANYA

Cruise No. 120

(27 December, 1996 - 31 January, 1997)

NATIONAL INSTITUTE OF OCEANOGRAPHY

(Council of Scientific and Industrial Research)

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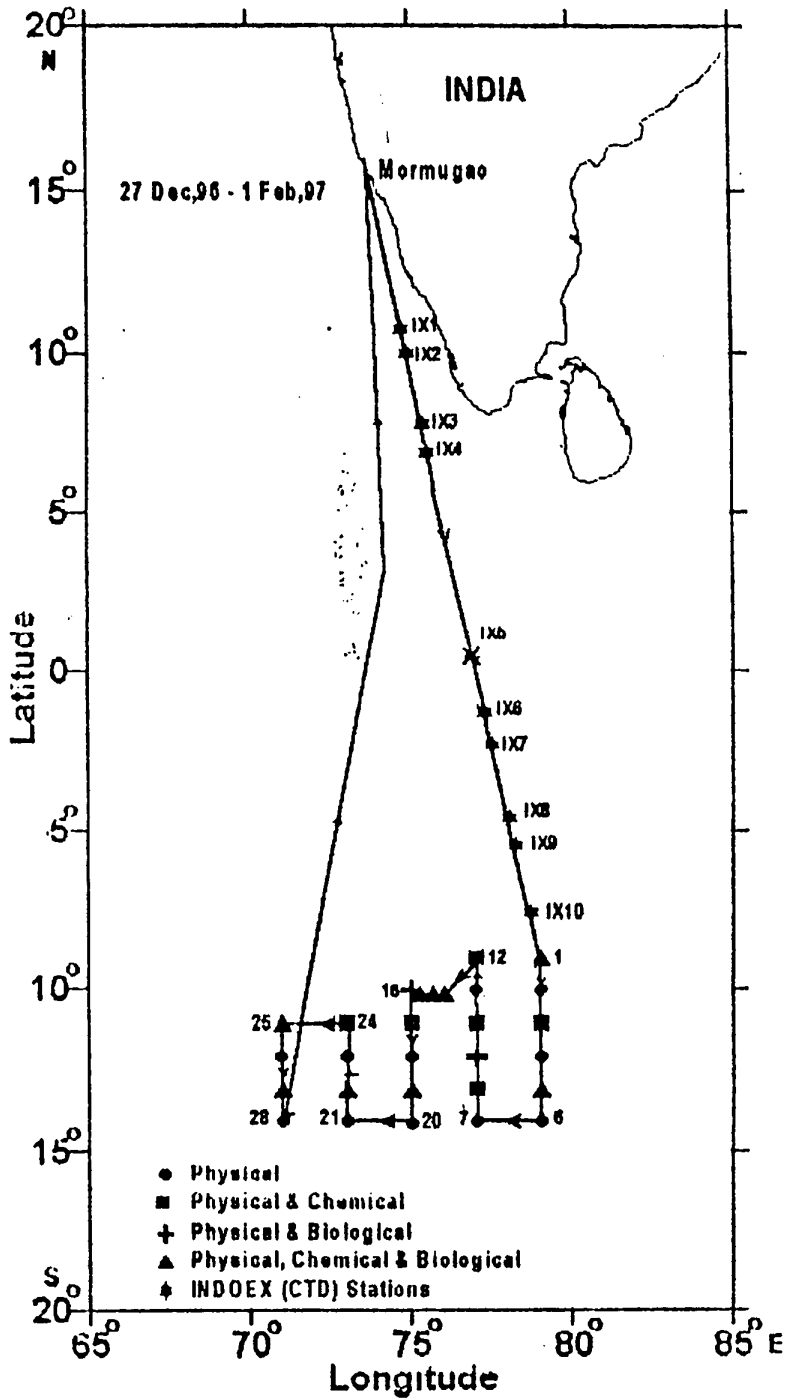
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REPORT ON THE 120TH OCEANOGRAPHIC CRUISE OF O.R.V. SAGAR KANYA

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ORV SAGAR KANYA CRUISE 120 TRACK



2. CRUISE SUMMARY

The cruise 120 of ORV Sagarkanya was primarily designated to collect baseline environmental data on physico-chemical and biological parameters of water column in the Central Indian Ocean Basin (CIOB) in connection with environmental impact assessment studies for ocean mining of poly-metallic nodules.

In addition to this, the cruise tracks were at advantage for conducting second pre-campaign of proposed Indian Ocean Experiment (INDOEX) during which profiles of various parameters relevant to aerosol forcing on global radiation were obtained.

On the way to EIA study area, shallow (0-200 m) CTD casts were taken at ten locations in conjunction with high resolution atmospheric soundings. Twenty-eight hydrographic stations were occupied in CIOB along five north-south transects (79°, 77°, 75°, 73° & 71° E) between 9°S and 14°S. Water samplings for analysis of various chemicals, primary productivity and micro-biological parameters as well as zooplankton samplings together with sun light penetration characteristics were obtained at some selected hydrographic stations.

The cruise commenced from Mormugao port on 27 December 1996 and ended at same port on 31 January 1997.

3. PARTICIPANTS

3.1 Scientific Component:

V.Ramesh Babu, Chief Scientist)	
R.J.K.Charyulu)	
E.P.Ramarao)	
S.N.D'souza)	
M.D.George	) —	NIO, Goa
Sugandhini Sardesai)	
Tejashree S.Tendulkar)	
Prabhu Mantondkar)	
M.S.Hussein)	
M.M. Subramaniam)	
K.K.C. Nair	) —	NIO RC, Cochin
Ranu Gupta)	
B.P. Rao	) —	NIO RC, Waltair
G.V.M. Gupta)	
K.S.Zalpuri)	
P.K. Gupta	) —	NPL, New Delhi
U.C. Kulsheshtra)	
T.K.Mandal)	
S.Ramachandran	) —	PRL, Ahemedabad
J.T. Vinchi)	
V.Gopalakrishnan	) —	IITM, Pune
Devdutta S.Niyogi	) —	IIT, New Delhi
L.K. Jain	) —	Indian Navy, Cochin
K.Lal)	
Biju V.Nair)	
Brian Telles	) —	NORINCO, Goa
P.Premachandran)	

3.2 Ship's Complement:

Capt. R.M. Verma	) —	Master
Sam Abraham	) —	Chief Officer
R.Pandey	) —	Third Officer
N.S. Bajwa	) —	Third Officer
R.Kumar	) —	TNOC
S.Roy	) —	Medical Officer
G.S.Nagarcenker	) —	Radio Officer
R.G.S. D'Silva	) —	Purser
S.Jannka	) —	Chief Engineer
V.Singh	) —	Second Engineer
H.K.Jain	) —	Third Engineer
P.K.Ekka	) —	Third Engineer
M.Mondal	) —	Fourth Engineer
Y.K.Bhusan	) —	Fifth Engineer
A.S.Bhatia	) —	Electrical Officer
K.P.Gupta	) —	Electrical Officer
L.M.F. Rodrigues	) —	Catering Officer

4. Objectives and Work Plan.

SK 120 cruise was originally proposed in the Bay of Bengal to cover WOCE section IR5 during northern winter season for estimating zonal volume transport across the section. However, the cruise plan was changed due to later developments which had warranted the immediate collection of baseline water column data in the Central Indian Ocean Basin (CIOB) in connection with Environmental Impact Assessment (EIA) study programme of poly-metallic nodules mining before executing benthic disturbance experiment on board a Russian ship. The revised plan of SK 120 cruise, therefore, had a primary objective of collecting hydrographic data at twenty eight locations in the CIOB wherein a total of five meridional transects between 9° and 14° S along 79°, 77°, 75°, 73°, 71°E were covered with a station distance interval of sixty nautical miles.

In addition to the requirements of PMN/EIA's study, the proposed cruise tracks from Mormugao port to CIOB and back were seen at advantage to carryout second pre-campaign of the Indian Ocean Experiment (INDOEX) - an international observational programme scheduled during northern winter seasons of 1998/ 1999 for assessing the forcings of aerosols and clouds over the tropical Indian Ocean on global radiation. Accordingly, various experiments relevant to INDOEX were planned to be executed by the scientists from different national agencies during the cruise.

5. CRUISE DETAILS

SK 120 cruise commenced from Mormugao port on 27 December 1997 after installation of a new CTD winch (make: Seamac Inc., USA) along with a new cable of 7000 m length. Prior to the cruise, the ship sailed out of port on 26 December 1996 / 1730 hrs IST for testing the CTD winch at a location off Goa coast where the water depth was around 570 m and returned to the port on the morning of 27 December 1997.

Fig. 1 shows the locations of hydrographic stations occupied in CIOB during this cruise. Also included in this figure are the locations of ten stations at which CTD profiles upto 200 m, coinciding with atmospheric soundings, were taken under INDOEX second pre-campaign programme.

Expendable Bathy-thermograph (XBT) was operated at 12 CTD stations to obtain temperature records for comparing with CTD data as a part of NIO's study on XBT data quality improvement.

Table 1 presents the details of hydrographic stations occupied during the cruise. The scientific work carried out during the cruise is separately described below under PMN/EIA study and INDOEX programs.

PMN/EIA Study:

Ship had reached the first hydrographic station at 9°S & 79°S on 4 January 1997 and finally completed the last station (Stn. No 28) on the night of 22 January 1997.

Physical:

CTD profiles were taken from 28 stations and the data were processed with a bin average interval of 10 m using Seabird's software (Seasoft) programs. Water samples were collected to estimate salinity with the help of a shipborne Salinometer (Autosal) which was standardized with a standard seawater sample. A regression relation between CTD and Autosal salinity data sets was obtained for applying necessary corrections to the former data set. Data on surface marine meteorological parameters such as wind speed and direction, atmospheric pressure, humidity and air and sea surface temperatures

were collected in general at three hourly synoptic hours except at 0230 LT. The participants from Indian Navy were exposed to CTD operations and they also took part in the surface meteorological observations programme.

Chemical:

Water samples from different depths collected at 15 stations were analyzed for various chemical parameters viz., dissolved oxygen, pH, alkalinity, nitrate, nitrite, phosphate and silicate. Both pH and alkalinity were estimated by calorimetric method using cresol Red White and Bromo Cresol Green respectively. The nutrients except phosphate were measured using Skalar Autoanalyser which had a problem with phosphate channel. The phosphate estimates were obtained manually using spectrophotometer.

Water samples were filtered and the filters were preserved for subsequent measurements of suspended particulate matter and particulate organic matter in the shore laboratory. Also water samples at 9 stations were filtered for analysis of trace metals in particulate and dissolved forms. The filters were preserved for analysis of metals in particulate form whereas the filtrates were extracted with organic compounds for analysis of dissolved metals. For dissolved iron, zinc, copper and manganese estimates, some fractions of the filtrates were first chelated with sodium diethyl dithiocarbamate (SDDC) at pH 5.5 and then extracted with organic solvent methyl isobutyl ketone (MIBK). Later, they were back extracted in inorganic acid (nitric acid) and preserved for analysis in the shore laboratory by atomic absorption spectrophotometry (AAS). The other fractions of filtrates were chelated with ammonium pyrrolidine dithiocarbamate (APDC) at pH 3.0 for the analysis of dissolved metals - cadmium, lead, cobalt and nickel. These were then extracted and back extracted in a similar way as mentioned earlier and preserved for subsequent analysis by graphite furnace atomic absorption spectrometry (GFAAS) in the shore laboratory. For calibration purpose, distilled water blanks and three sets of standards were also extracted similar way and preserved.

Biological:

Following investigations on primary, secondary and microbiological productions were carried out for 11 stations.

- i) Primary production - Samples collected in 0-150 m depth range were preserved for taxonomical investigations. For Chlorophyll *a* estimations, two litre samples from euphotic zone were first filtered using GF/F filters. Chlorophyll *a* was extracted in 90% acetone and later measured with the help of a Turner fluorometer. The primary production rates were estimated using C-14 technique. The penetration of sun light at various depths was also estimated using Biospherical-Spectro-Radiometer
- ii) Secondary production - Zooplankton samples were collected using a Multiple Plankton Net (MPN) '300 micron' (Make: Hydrobios, Germany) which had an operational range up to 1000 m depth only. From each station, samples were collected in five different layers viz., isothermal, thermocline, below thermocline, 300-500 m and 500-1000 m. The samples were preserved in 4% formaldehyde for further analysis after estimating the biomass by the standard displacement method. WP net (300 micron) was used at station 27 to collect zooplankton sample in upper 250 m layer and this special sample was meant for CHN analysis in order to assess the energy components.
- iii) Micro-biological production - Water samples collected from near surface to deeper depths were preserved for total counts of bacteria using glutaraldehyde. The total bacterial production was studied using H-3 Thymidine isotope. For marine yeast

studies, the water samples were incubated on a yeast-nutrient media for isolation and identification.

INDOEX PROGRAMME:

In the second pre-campaign of INDOEX, the participating institutes from Indian side were National Physical Laboratory (NPL), New Delhi; Physical Research Laboratory (PRL), Ahmedabad; Indian Institute of Tropical Meteorology (IITM), Pune; Space Physics Laboratory (SPL) of Vikram Sarabhai Space Center (VSSC), Trivandrum; Indian Institute of Technology (IIT), New Delhi and Indian Institute of Science, Bangalore. Indian scientists from some of these national organizations had also conducted experiments by operating various instruments supplied from foreign collaborators of INDOEX programme.

NPL Work:

- i) A high volume aerosol sampler was deployed to measure the levels of total particulate matter (TPM), SO₂, NO and NO₂ in the surface air which was sucked into the sampler through filters over 24 hrs period. The suspended particulate matter as deposited on filter papers would be subsequently analyzed for various components at shore laboratory.
- ii) Rain water was collected for pH analysis using manual collectors whenever there was rain.
- iii) Ship's en route monitoring of green house gases (methane, CO₂, N₂O, and CO) was done by collecting ambient air in stainless steel samplers. The air samples would be analyzed in the shore laboratory using Gas Chromatograph.
- iv) NPL scientists also conducted various experiments by operating instruments from following U.S and other foreign contributors of INDOEX.

a) Scripps Institute of Oceanography, USA (Center for Clouds, Chemistry & Climate):-

Radiation measurements were obtained by using different radiometers operated in the broad bands of 300-2800 nm and 700 -2800 nm as well as in the six discrete channels of ultraviolet, visible and near infrared ranges. The data were averaged over 30 sec and one minute intervals for broad band and discrete channels respectively.

b) University of Miami, USA:-

Aerosol sampling at 12 hrs interval was taken with the help of a high volume aerosol sampler which had an arrangement to draw uncontaminated air samples through a wind direction controller.

A high volume aerosol sampler having 5-stages for sampling aerosols of different sizes was operated. The samples were collected at 24 hrs interval along the ship's track with emphasis on deriving information on Cl⁻¹ in the particulate matter.

c) University of California, USA (Dept. of chemistry):-

A four stage Sierra type high volume aerosol sampler for deriving information about sulfate isotopes was operated by collecting samples at every 48 hrs. Surface sea water samples locations were also collected at five locations to provide reference points.

d) University of Alaska, USA:-

A cloud condensation nuclei (CCN) spectrometer was used to determine CCN distribution in the ambient air.

e) *Stockholm University, Sweden (Dept. of Meteorology):-*

A rain water collector with a lid opening automatically during rain only was installed and operated to obtain uncontaminated rain water samples.

PRL Work:

Scientists from PRL, Ahmedabad conducted following experiments:

- i) Solar radiation intensities in five spectral bands centered around 400, 500, 650, 850 and 1050 nm were measured using a hand-held Sun photometer for every 15 minutes from sunrise to sunset on clear sky days. These measurements were intended to obtain the aerosol optical depths. Instantaneous direct solar radiation measurements in different bands of spectrum were also taken by using a pyrheliometer in coordination with Sun photometer measurements.
- ii) Measurements of aerosol mass concentrations and size distributions using a Quartz Crystal Micro balance Impactor were made four times a day at 08, 12, 16 and 2100 hrs.
- iii) Continuous monitoring of surface trace gases such as ozone and CO along the ship's route was done by respective ozone and CO analyzers.

IITM's Work:

- i) The marine atmospheric ion conductivity serving as an indirect index of pollution was measured by using a Gerdien's apparatus with a measuring range from 0.3 to 6.0×10^{-14} mho/m.
- ii) The atmospheric electric field over the ocean was also measured with the help of Electrometer and Am -136 radioactive probe in order to improve the understanding of the Global Electric Circuit.

IIT(Delhi)/IISc/SPL(VSSC)'s Combined work:

- i) The marine boundary layer's characteristics of turbulence (fluctuations in temperature, humidity and wind fields) were measured by both fast (10 Hz sampling) and slow (1 Hz sampling) response sensors that were placed on a boom extended outward directly over the sea surface. Though the slow acquisition of data was continuous, the fast acquisition was intermittent with a typical sample length of 40 minutes collected every six hours or whenever the wind direction was suitable. The slow measurements (1 Hz, averaged over 3 min, continuous) were taken using cup anemometer and wind vane (for horizontal wind field), Humicap (for relative humidity) while the fast measurements (10 Hz, instantaneous, intermittent) involved the sensors of sonic anemometer with platinum thermistor (for vertical wind component and temperature fluctuations around mean), three-axis Gill propeller anemometer (for u,v,w components of wind vector), Humicap (for relative humidity fluctuations) and platinum resistance thermistor (for temperature fluctuations).
- ii) In addition to the above surface measurements, the variations in wind speed & direction, air temperature (dry/wet) with height were measured with help of a Cross-chained Lorenz Atmospheric Sounding System (CLASS) having a vertical resolution of 30 to 40 m. CLASS was obtained from USA' National Center for Atmospheric Research and National Science Foundation through a joint proposal from U.S Institutes viz., North Carolina State University, National Center for Atmospheric Research and Scripps Institute of Oceanography (Center for Clouds, Chemistry and Climate) and operated by Indian scientists. Vaisala radiosondes

(RS-80) were released daily twice at 0630 and 1330 LT with the help of balloons filled with helium gas. Additional radiosonde ascents were made to provide calibration data for NOAA-AVHRR and GPS satellites.

6. PRELIMINARY RESULTS

A. PMN-EIA STUDY:

Physical:

- i) The upper oceanic mixed layer in CIOB varied between 10 and 40 m. The sea surface temperature varied from 28.0 to 29.0 °C.
- ii) Surface salinity showed a general decreasing tendency towards southwest in CIOB and strong near-surface halocline was seen in upper 25 m layer at a few isolated locations.
- iii) The vertical salinity structures were characterized with a sub-surface salinity maximum and an intermediate minimum around 75 and 1000 m depths respectively while the depth-salinity variations were very small below 2000 m.

Chemical:

- i) High concentrations (3.5 to 5.5 ml/l) of dissolved oxygen were present in association with low nutrient concentrations.
- ii) The intermediate oxygen minimum values around 300 m depth did not fall below 1.5 ml/l unlike in the Arabian Sea.
- iii) The bottom waters in the CIOB were characterized with high concentrations of nutrients and dissolved oxygen.
- iv) Nitrite values showed only primary maximum in the depth range of 50-150 m with maximum concentration of 1.02 $\mu\text{mol/l}$. No secondary nitrite maximum was observed.

Biological:

- i) Though chlorophyll *a* was detected up to 150 m depth, maximum chlorophyll and primary production were encountered in the depth range of 50-75 m.
- ii) The oligotrophic waters of the area revealed very low secondary standing stock, more so in the deeper layers (300 - 1000 m) where it ranged from negligible to 0.024 ml/m^3 . In upper euphotic zone (0-150 m), the range was between 0.03 and 0.27 ml/m^3 .
- iii) One of the samples from a deeper depth (5000 m) at stn.1 contained decaying appendage of a crustacean. On incubation of this sample in a yeast-nutrient media, the growth of filamentous yeast was observed emerging from the appendage.

B. INDOEX STUDY:

The preliminary results from meteorological component of INDOEX indicate

- i) A strong advent of the sea breeze / land breeze effect till a significant distance away from the continent.
- ii) A diurnal effect in the boundary layer height.
- iii) A consistent multi-layered tropopause over the tropical ocean.

7. OPERATIONAL PROBLEMS

Gaps were noticed in between the strands of the outer armour part of new CTD cable which was wound on a newly installed winch (Make:Sea-Mac Inc. USA). This had led to the weakening of the cable and the lowering of CTD with new cable nearer to sea bed after fourth hydrographic station (No.SK 120/04) was therefore suspended. The old CTD cable with available length of 4000 m wound separately on an old winch was used for lowering of CTD at subsequent stations. A test of the new CTD cable with an appropriate dummy weight of 750 Kg was attempted on 9 January '97 after cutting its weakened part of about 1300 m length and the gaps on cable's outer armour were continued to form during test. The rewinding of the cable was also affected at both the ends of the drum. It was suspected that i) possible twist on the cable ii) cable quality and iii) distance of pulley from drum may be possible causative factors acting either combinely or independently for formation of gaps. A detailed note of observations regarding new CTD winch and cable was prepared and communicated to NIO from the ship.

About 100 m length of old CTD cable in total was cut at few occassions whenever the cable was found weak. At present, the old CTD cable wound on old drum has a length of about 3900 m but with a payout length of 3500 to 3600 m. This had restricted the CTD probing and water sampling at very deeper and abyssal depths in CIOB.

8. SUGGESTIONS

The following are suggested:

- a) procurement of spares for new CTD winch (Sea-Mac) and replacement of CTD cable at the earliest.
- b) a regular housing arrangement for the payout indicator of new CTD cable along with its special power supply unit (115 V) near the winch.
- c) general facility for INS data downloading to PC based floppy diskettes.
- d) calibration of ship borne wave recorder during ensuing dry dock and lay-up period.
- e) Alignment of boom supporting the atmospheric turbulence measuring sensors in parallel to the ship's center line (presently the boom is at an angle of about 25 degrees) and its easier motion through a motor.

9.ACKNOWLEDGEMENTS

The Chief Scientist and other participants of SK120 cruise acknowledge with thanks the cooperation given by the Ship's master, officers and crew.

Table 1: Details of hydrographic stations.

STN. NO.	DATE	TIME (IST)	LAT.	LONG. (E)	CHART(C) / SONIC(S) DEPTH (m)	XST	PRIMARY	WATER MICRC	SAMPLING CHEMICAL	ZOOPLAKTON SAMPLING	REMARKS
IX-01	29.12.96	0538/0800	10°44' N	74°43'	2000C	X	X	X	X	X	INDEX Stn. -do-
IX-02	29.12.96	1315/1536	10°02' N	74°54'	2200C	X	X	X	X	X	-do-
IX-03	30.12.96	0541/0718	07°47' N	75°23'	2100C	X	X	X	X	X	-do-
IX-04	30.12.96	1315/1542	06°55' N	75°31'	2000C	X	X	X	X	X	-do-
IX-05	01.01.97	1315/1454	00°48' N	76°49'	4500C	X	X	X	X	X	-do-
IX-06	02.01.97	0541/0724	01°17' S	77°18'	4800C	X	X	X	X	X	-do-
IX-07	02.01.97	1315/1518	02°15' S	77°32'	4900C	X	X	X	X	X	-do-
IX-08	03.01.97	0540/0720	04°37' S	77°04'	4900C	X	X	X	X	X	-do-
IX-09	03.01.97	1312/1440	05°28' S	78°14'	4900C	X	X	X	X	X	-do-
IX-10	04.01.97	0545/0730	07°36' S	78°40'	4900C	X	X	X	X	X	-do-
12001	04.01.97	1658/0515	09°00' S	78°59'	5250S	X	X	X	X	X	PMN/EIA Stn. -do-
	05.01.97										
12002	05.01.97	1155/1854	10°01' S	78°59'	5100S	X	X	X	X	X	-do-
12003	06.01.97	0100/1342	11°00' S	79°00'	5300S	X	X	X	X	X	-do-
12004	06.01.97	2045/0645	12°00' S	79°00'	5375S	X	X	X	X	X	-do-
	07.01.97										
12005	07.01.97	1530/0115	12°59' S	79°00'	4830S	X	X	X	X	X	-do-
	08.01.97										
12006	08.01.97	0905/1254	14°00' S	79°00'	4530S	X	X	X	X	X	-do-
12007	09.01.97	0300/0610	14°00' S	77°00'	5200S	X	X	X	X	X	-do-
12008	09.01.97	1350/1840	13°00' S	77°00'	5350S	X	X	X	X	X	-do-

x= Not Operated; * = Operated

Table 1: Details of hydrographic stations.

STN. NC.	DATE	TIME (IST)	LAT.	LONG. (E)	CHART (c) / SONIC (s) DEPTH (m)	CTD CAST DEPTH (m)	XBT	PRIMARY	WATER MICRO	SAMPLING CHEMICAL	ZOOPLAKTON SAMPLING	REMARKS
12009	10.01.97	1758/0335	12°00'S	77°03'	5370C	1355	*	*	*	X	*	-do-
	11.01.97											
12010	11.01.97	1910/0032	11°00'S	77°00'	5290C	2690	*	*	*	*	X	-do-
	12.01.97											
12011	12.01.97	1020/1500	10°00'S	77°00'	5270C	2375	*	*	*	X	X	-do-
12012	12.01.97	2350/0534	09°00'S	77°00'	5280C	3295	X	*	*	*	X	-do-
	13.01.97											
12013	13.01.97	1639/0620	10°05'S	76°00'	5300S	4410	X	*	*	*	*	-do-
12014	14.01.97	0918/1350	10°05'S	75°40'	5325S	3575	X	*	*	*	*	-do-
	15.01.97											
12015	15.01.97	1711/0210	10°05'S	75°15'	5250S	3155	X	*	*	*	*	-do-
	16.01.97											
12016	16.01.97	0518/1210	10°00'S	75°00'	5200S	2110	X	*	*	X	*	-do-
12017	16.01.97	1945/0050	11°00'S	75°00'	5280S	3570	*	X	X	*	X	-do-
	17.01.97											
12018	17.01.97	0654/1025	12°00'S	75°00'	5100S	3415	X	*	*	X	X	-do-
12019	17.01.97	1710/2325	13°00'S	75°00'	5200S	3505	X	*	*	*	*	-do-
12020	18.01.97	0550/1300	14°00'S	75°00'	5200S	3325	X	*	*	X	X	-do-
12021	19.01.97	0120/0512	14°00'S	73°00'	4700S	3465	X	X	X	X	X	-do-
12022	20.01.97	1200/1920	13°00'S	73°00'	4800S	3515	*	*	*	*	*	-do-
12023	20.01.97	0240/0730	12°00'S	73°00'	4400S	3505	X	X	X	X	X	-do-
12024	20.01.97	1412/1914	11°00'S	73°00'	5100S	3385	X	X	X	*	X	-do-

x = Not Operated; * = Operated

Table 1: Details of hydrographic stations.

STN. NO.	DATE	TIME (IST)	LAT.	LONG. (E)	CHART (C) / SONIC (S) DEPTH (m)	CTD CAST DEPTH (m)	XBT	PRIMARY	WATER MICRO	SAMPLING CHEMICAL	ZOOPLAKTON SAMPLING	REMARKS
12025	21.01.97	0740/1348	11°00' S	71°00' E	3200S	3185	x	*	*	*	*	-do-
12026	21.01.97	2030/0035	12°00' S	71°00' E	3525S	3500	x	x	x	x	x	-do-
	22.01.97											
12027	22.01.97	0717/1230	13°00' S	71°00' E	3800S	3255	x	*	*	*	*	-do-
12028	22/01.97	2020/2305	14°00' S	71°00' E	4300S	2145	x	x	x	x	x	-do-

x = Not Operated; * = Operated