# Biogeochemistry of Tropical Indian Ocean during North east Monsoon

SK-265

04th November-07th D

Cruise Report Submitted to NCAOR

## ***Acknowledgement***

*We the scientific team of SK-265 onboard Sagar Kanya are grateful to the Secretary, Ministry of Earth Sciences for the immense help provided by his for the successful execution of this northeast monsoon cruise programme of the Tropical Indian Ocean Studies. We are thankful to the Director, NCAOR and Dr. AnilKumar [GD, OSSG] and Dr. Achuthankutty, Scientist Emeritus for their constant support in the successful implementation of this expedition. We thank the Master, Chief Engineer, Chief Officer and crew members of ORV Sagar Kanya for their supreme co-operation throughout the cruise. We thank the NORINCO engineers for the service provided by them in operating all the required scientific equipments onboard for the successful completion of this cruise.*

***[RACHEAL CHACKO]***

***CHIEF SCIENTIST***

## ***Objectives and expected results***

1. A comprehensive understanding of the physical, chemical, and biological aspects of the tropical Indian Ocean. Studies related to the Equatorial Current system, Water masses and Zonal transport.
2. To understand the nutrient chemistry of the study region from the water samples collected from different depths.
3. The meteorological archive will be useful for a comprehensive understanding of the climatic variabilities.
4. To determine the total quantity of chlorophyll by spectrophotometric method.
5. To prepare samples for ATP analysis.

For understanding the biogeochemistry of the tropical Indian Ocean a detailed data collection was planned at one degree latitude from 18°S including water sample collection from different depths. Intensive sampling was carried out from 5°S to 16°S along 64°E, 65°E, 66°E and 67°E longitudes.

These all data archive will be useful for detailed approach to understand the climatic variabilities.

## ***Participating Organizations***

1. NATIONAL CENTRE FOR ANTARCTIC & OCEAN RESEARCH (NCAOR)
2. NATIONAL INSTITUTE OF OCEANOGRAPHY
3. JES COLLEGE, JALNA
4. NORINCO

## ***Equipments operated/tested***

1) Single beam Echo sounder

2) Conductivity Temperature Depth [CTD] with rosette samplers - make Seabird
3) Conductivity Temperature Depth [CTD] with rosette samplers - make Idronaut
4) Portable CTD
5) MPN
6) Autosal
7) RBR Salinometer
8) Sound Velocity Profiler
9) Magnetometer
10) Expendable Bathythermograph (XBT)
11) Automatic Weather Station

## ***Diary of Events***

**04-11-2009**-The scientific team boarded the vessel after completion of signing on procedures at 1100 hrs. Vessel moved to outer anchorage at 1830 hrs to await the arrival of SCI personnel. The members boarded the vessel at 2130 hrs and vessel started its journey to the first station i.e. 10 N 65 E.

**05-11-2009**-A meeting of all the participants was called and the operations and sampling strategy was discussed. Meteorological observations were started at 4 hourly intervals.

**06-11-2009**- Meteorological observations were started at 4 hourly intervals. Vessel expected to reach first station by tomorrow afternoon.

**07-11-2009**-Vessel reached first station i.e. 10N 65E at 1430 hrs. The portable CTD was attached with the SBE CTD and it was lowered to a depth of 3000m. Water samples were collected from standard depths for analysis of various chemical and biological parameters. MPN was also deployed. Competed the station at 1830 hrs and vessel proceed to the next station i.e. 09N. 4-hourly meteorological observations are being carried out.

**08-11-2009**-Vessel reached 09N at 0030 hrs. There was no water sample collection or MPN operation at this station. Both SBE CTD and pCTD was deployed. Completed the station at 0310 hrs and vessel proceeded to the next station i.e. 08N. Vessel reached 08N at 0930 hrs. CTD and MPN operations were carried out. Station completed at 1320 hrs. Vessel moved to 07N and reached at 1940 hrs. Only CTD's were deployed. Station completed at 2210 hrs. Vessel moving to the next station. 4-hourly meteorological observations are being carried out.

**09-11-2009**-Vessel reached 06N at 0430 hrs. At this station both CTD as well as MPN operations were carried out and the station was completed at 0835 hrs. Vessel proceeded to 05N. Vessel reached 05N at 1450 hrs. The SBE and PCTD were deployed to 3000m. There was no water sample collection or MPN operation at this station. Station completed at 1710 hrs. Vessel moved to next location at 04N. Wind speed has started picking up and winds are around 20 knots. 4-hourly meteorological observations are being carried out.

**10-11-2009**-Vessel reached 03 N at 1100 hrs. Winds around 27 knots average. DP was operated manually. We deployed the CTD to 2000 m only. Completed the station at 1400 hrs. Vessel moved to next location i.e. 02 N. Reached 02N at 2330 hrs. Average wind speed 36 knots. We could not carry out any operation. After discussion with master it was decided

that we would drift and carry out the operation when the weather gets better. 4-hourly meteorological observations are being carried out.

**11-11-2009**-Today at 0900 hrs we came back to the actual location (2N). Weather conditions were very much the same. After being on DP the vessel was drifting at 3 knots. We have cancelled operation at 02 N and we are proceeding to 01N. Vessel reached 01 N at 1830 hrs. Deployed CTD to 1200m only. Winds average 24 knts. Water samples were collected between 0-200m. Completed station at 2200 hrs. Vessel moved to equator 00 , 65 E. 4-hourly meteorological observations are being carried out.

**12-11-2009**-Reached equator at 0615 hrs. CTD's deployed to 1500m. Water sampling done between 0-1000m. MPN operation was also carried out. Sea rough and winds are still strong. Completed the station at 1045 hrs and vessel proceeded to 01S 65E. Vessel reached 01 S at 1830 hrs on 12-11-2009. CTD's were deployed to 2000m. Sea still rough and winds average 24 knots. Completed station at 2145 hrs and vessel proceeded to 02S. 4-hourly meteorological observations are being carried out.

**13-11-2009**-Vessel reached 02S at 0500 hrs. CTD was deployed to 2500 m. When the first bottle was fired at 1000m it did not fire and communication could not be established with the carousel. Even after restarting the system the same problem persisted but there is communication with the CTD unit so we decided to get the system back to deck. At 500m we tried again and we were successful in establishing communication. After that all the bottles fired. The CTD was deployed a second time for water collection upto 75m. All the bottles fired. MPN couldn't be operated. Vessel moved towards next station i.e. 03S. We have gale and bad weather warnings for 4S. Vessel reached 03S at 1700 hrs on 13-11-2009. CTD's were deployed to 3000m. Completed the station at 2050hrs and vessel proceed to next station. 4-hourly meteorological observations are being carried out.

**14-11-2009**-Reached 04S at 0400 hrs. CTD's were deployed to 2000m. MPN was also operated. Completed the station at 0815hrs and vessel moving towards 05S. Vessel reached 05S at 1720 hrs. CTD's were deployed to 3000m. Completed the station at 2130 hrs and vessel moved to the next station. 4-hourly meteorological observations are being carried out.

**5-11-2009**-Vessel reached 06S at 0700 hrs. Heavy rains and high winds delayed the deployment of CTD's. Resumed scientific operations at 0930 hrs. CTD deployed to 3000m.

MPN couldn't be operated. Completed the station at 1500 hrs. Weather report shows the presence of a storm at around 12S. Vessel moved to 07S.

**16-11-2009**-Vessel reached 07S at 00hrs. Only CTD's were deployed to 3000m. Completed the station at 0238 hrs. Vessel moving to first station in the zigzag i.e. 08S 66E. Vessel reached 08S 66E at 1245 hrs. CTD's were deployed till 3000m. MPN was also operated. Completed the station at 1557 hrs. Vessel proceeded to 08S 65E. Reached the station at 2230 hrs. CTD's were deployed till 3000m. MPN was also operated.

**17-11-2009**-Completed the station at 08S 65E at 0215 hrs. Vessel proceeded to 09S 64E. Reached station at 0900 hrs. At 098S 64E, the CTD's were deployed to 3000m. But again the unit didn't fire at 1000m So the instrument was brought back on deck. The connectors were dried and greased and deployed back to 1000m. The bottles fired after that. MPN operations were also carried out. Completed the station at 1400 hrs. Vessel proceeded to 09S 65E. Reached the station at 2300 hrs. The CTD's were deployed. When the CTD reached 192m a loud beeping sound was heard and the deck unit went off. The fuse had blown off. This usually happens when there is water entry in the sea cable. CTD was brought back on deck. When checked for connectivity, the cable didn't show any connectivity. 30 m of the cable was cut. The cable showed connectivity after that. But the deck unit was still not getting communicating with the CTD. The cable was then connected to the MPN. The MPN console showed the message 'cable short circuit' But communication could be established with the MPN. After checking again it was found that there was a short circuit at the pig tail joint. This was replaced and communication with the deck unit could be established.

**18-11-2009**-After rectification of the short circuit the CTD's were deployed to 2000m. Water samples were collected. MPN was operated. Completed the station at 0830 hrs. Vessel moved towards 10S 66E. Vessel reached 10S 66E at 1555 hrs. CTD's were deployed till 3000m. MPN was also lowered. Station completed at 1925 hrs and vessel moved to next station.

**19-11-2009**-Vessel reached 10S 65 at 0130 hrs. CTD's and MPN were deployed. Testing of Idronaut CTD was tried. But we were not successful. It was seen that the carousal is selected as GO 1014 by default whereas the carousal that we have onboard is Intelligent carousal GO 1018. The sampler selection menu is disabled so the sampler type cannot be selected. Secondly the Sampler instrument worked well but the software didn't start when the sampler was deployed in water. The software was reinstalled but the problem persisted. OEM was

informed and further information is awaited. Vessel reached 10S 64E at 1345 hrs. CTD's were deployed till 3000m. MPN was also lowered. The station was completed at 1735 hrs. Vessel proceeded to 11S 65E.

**20-11-2009**-Reached the station at 0430 hrs. CTD's and MPN were deployed. Completed the station at 0820 hrs. Vessel moving to the next station. Vessel reached 12S 66E at 1840 hrs. CTD's were deployed till 2000m. MPN was also lowered. Completed the station at 2230 hours. Vessel proceeded to 12S 65 E.

**21-11-2009**-Reached station at 0340 hrs. Both Seabird CTD and portable CTD were deployed to 2800m. MPN was operated up to 300m. Completed the station at 0811 hrs. Vessel moving to next station i.e. 12S 64E. Vessel reached 12S 64E at 1330 hrs. CTD's were deployed till 3000m. MPN was also lowered. Completed the station at 1720 hours. Vessel moved to 13S 65E.

**22-11-2009**-Vessel reached station at 0400 hrs. CTD's were deployed till 3000. MPN operation had to be cancelled to heavy rains and high wind speed. Vessel moved from station at 0800 hrs. Vessel proceeding to 14S 66E. Vessel reached 14S 66E at 1950 hrs. During the deployment of the CTD's as soon as the CTD reached 490m we heard a loud beep. We stopped the CTD and brought it back on the deck. MPN was lowered till 500m to check if there was any problem with the cable. We could operate the MPN successfully. After MPN was got on deck when the sea cable was again connected we couldn't establish communication with the instrument. At this time it was observed that the pig tail joint was getting heated. So we cut around 5 m of cable and the connection was redone.

**23-11-2009**-After this the CTD was deployed to 2000m and water samples were also collected. Station was completed at 0315hrs and vessel moved to next station i.e. 14S 65E. Vessel reached station at 0900 hrs. CTD operations are being carried out and MPN will also be operated after this. Completed station 14S 65E at 1230 hrs. Vessel proceeded to 14S 64 E. Vessel reached station at 1840 hrs. CTD as well as MPN was deployed. Completed station at 2235 hrs. Vessel moved to next station.

**24-11-2009**-Reached 15S 65 E at 0850 hrs. At 15S 65E when the CTD was deployed for the shallow cast the same problem resurfaced. The communication with the instrument was lost. When the CTD was brought back to the deck it was observed that the problem was again with

the pig tail joint. The cable was re-spliced and operations were carried out after that. Completed the station at 1716 hrs. Vessel moved to 16S 65E.

**25-11-2009**-Reached 16S 65E at 00 hrs. CTD was deployed to 2500m. MPN was also operated. Completed the station at 0330 hrs. Vessel proceeded to 17S 65E and reached station at 1000 hrs. Completed station 17S 65E at 1530 hrs after operation of CTD and MPN. Vessel moved to 18S 65E and reached the station at 2300 hrs.

**26-11-2009**-Completed station at 0600 hrs after completion of CTD and MPN operations. Vessel starting return journey to Mourmugoa. Vessel reached 16S 66E at 2330 hrs. CTDs were lowered to 2200m.

**27-11-2009**-At 1000m the bottles did not fire. The carousel didn't respond. They started firing at 300m only this was the time when the carousel responded. After the CTD was brought back on deck the connectors were checked and greased and deployed again. But the same thing happened again. The bottles fired only from 300m. So sampling was restricted to 300m. MPN was also operated. Completed the station at 0400 hrs. Vessel resumed sailing.

**28-11-2009**-XBT's are being lunched at 1 degree interval. Meteorological observations being carried out at 4 hourly intervals.

**29-11-2009**-XBT's are being lunched at 1 degree interval. Meteorological observations being carried out at 4 hourly intervals. Vessel reached 07S 67E at 1400 hrs. CTD's were deployed to 1000m. MPN operation was also carried out. Completed the station at 1605 and vessel moved to next station. Reached 06S 67E at 2200 hrs. CTD's were deployed to 1000m. MPN operation was also carried out.

**30-11-2009**-Completed the station at 0005 hrs and vessel moved to 05S 67E and reached station at 0600 hrs. Completed the station at 0735 hrs and vessel moving to 05S 67E. It was observed that the threading of the bulkhead connector of the carousel had become loose. This could have been the reason why the bottles were not firing beyond 300m. The connector was tightened. After that the bottles have fired at all the depths. The magnetometer was tested on deck and was found to be working satisfactorily. The instrument will be deployed in the afternoon station. Vessel reached 04S 67E at 1330 hrs. CTD's were deployed to 1000m. MPN was also deployed to 300m. The sound velocity profiler was also tested in the station. Magnetometer operation was postponed for the following day as it was 1600 hrs when the station was completed. Vessel resumed sailing after completion of station.

**01-12-2009**-The magnetometer was deployed at 1115 hrs and brought back to deck at 1700 hrs. Vessel resumed its journey to Goa after the completion of operation. XBT's are being lunched at 1 degree interval. Meteorological observations being carried out at 4 hourly intervals.

**02-12-2009**-The RBR salinometer was tested. It was observed that the analysing each sample takes minimum 8 minutes. The values are seen to be varying in the third and fourth decimal. The values are almost similar to that of the Autosal onboard. The performance is good other than the time involved in the analysis. XBT's are being lunched at 1 degree interval. Meteorological observations being carried out at 4 hourly intervals.

**03-12-2009 to 05-12-2009**-XBT's are being lunched at 1 degree interval.

**06-12-2009**-Vessel moving to Goa.

**07-12-2009**-Vessel reached Mormugoa and anchored at 0730 hrs. Scientific team disembarked from vessel.

## *Physical Oceanography Studies*

To have a better understanding of the thermohaline and current structure in the study area CTD and XBT observations were carried out. These observations were carried out at a $1^0$ degree interval. The results obtained from the hydrographic data (XBT, CTD) collected in the tropical Indian Ocean during this period when compared to the previous studies will be attributed to the significant annual changes occurring in the upper ocean thermal structure and variation in the boundary of the equatorial current system and its east west transport in the equatorial region.

## *Chemical Oceanography Studies*

The data collected during this expedition will be used to understand the various chemical processes such as nutrient chemistry, dissolved oxygen, trace metal processes of the study region from the water sample collected from different depths.

A total of 33 stations were sampled for chemical parameters. Water samples were collected from $10^0$N to $18^0$S for D.O. (dissolved oxygen), pH, nutrient and trace metals analysis from surface to 1000 m. (0m,20m,30m,50m,60m,75m,100m,120m,150m,200m,300m,500m,750m and 1000m). Water sample collection for D.O., pH and nutrients was done from every alternate degree from 10°N to 4°S.

Intensive sampling was carried out from 5°S to 16°S along 64°E, 65°E, 66°E and 67°E longitudes. Water sample collection from 17°S and 18°S was along 65°E longitude.

For trace metals analysis water samples were collected from 6°S, 67°E and 8°S, 10°S, 12°S, 14°S, 16°S and18 °S along 65 °E longitude.

**Onboard analysis:**

Dissolved Oxygen (D.O.): Water samples for dissolved oxygen were immediately fixed with Winkler A and Winkler B. Analysis was carried out soon after in the laboratory using the classical Winkler method.

Nutrient: 250ml water samples were collected for nutrient analysis (nitrate, nitrite, phosphate and silicate). Water samples were stored at -20° C and analyzed later onboard by autoanalyser.

pH: pH was measured onboard with portable pH meter.

Trace metals: Water samples were collected in 2L amber colored bottles and immediately fixed with supra pure $HNO_3$ by lowering the pH to 2. Further analysis will be carried out in the laboratory.

***Biological Oceanography Studies***

During the SK-265 cruise, a total of 33 stations were sampled for biological studies. The water samples were collected for Phytoplankton, Mesozooplankton , Microzooplankton, chlorophyll and microbial studies. A total of seven depths were taken for phytoplankton, microzooplankton, microbial studies and chlorophyll from surface to 120 m (0m, 20m, 30, 50m, 75m, 100m and 120m) and mesozooplankton was sampled at three depths i.e., Mixed layer depth, thermocline and bottom of thermocline to 300m.

**Onboard analysis:**

**Phytoplankton**: The samples were collected in 500 ml bottles and preserved immediately with Lugols iodine solution. These samples will be later concentrated to 20 ml and the planktons will identified under the microscope.

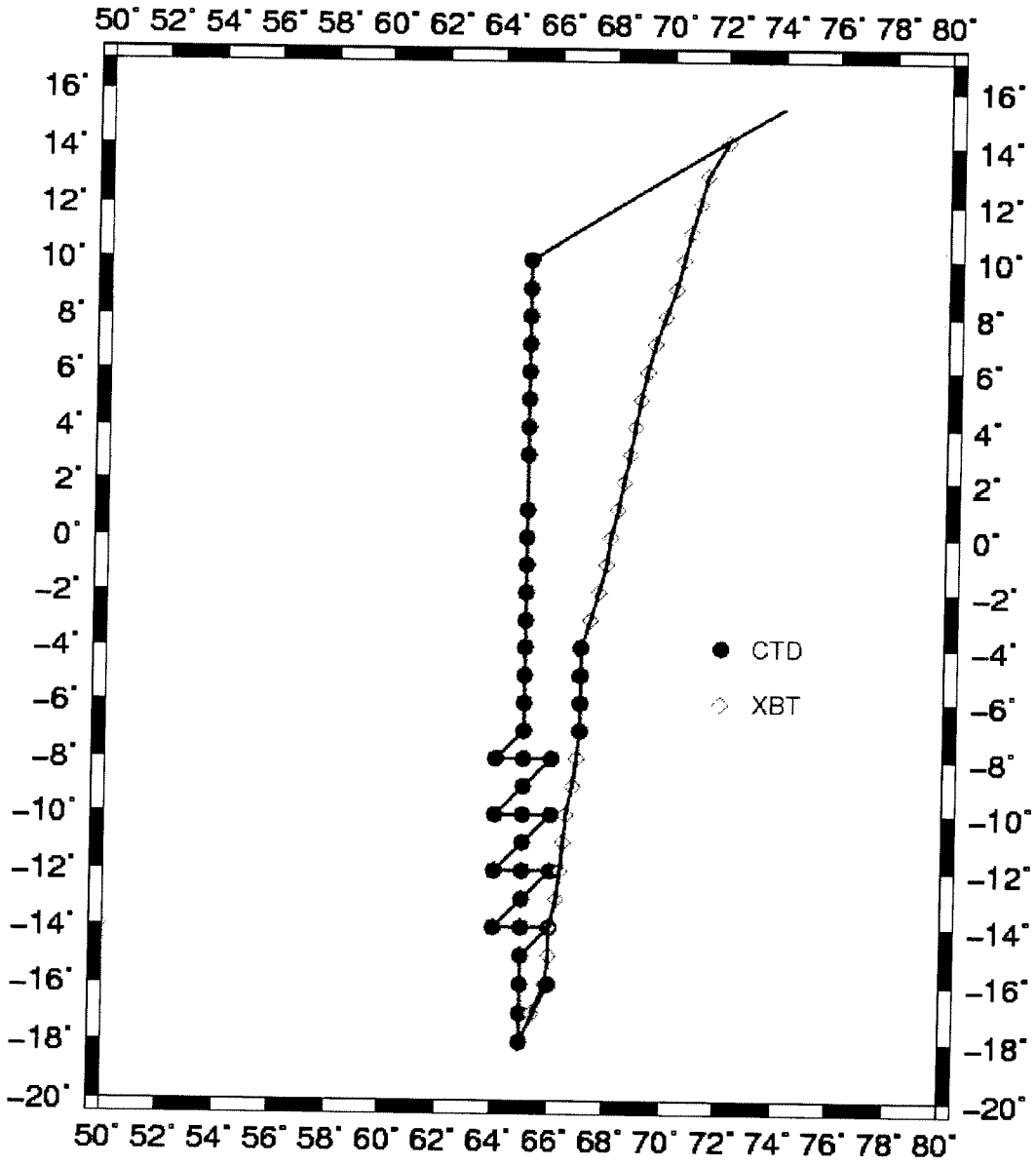
**Microzooplankton**: 3 litres of water sample was collected and filtered through 200μ mesh and further concentrated by siphoning through 20 μ mesh to approx. 250 ml and preserved with Lugols iodine containing strontium sulphate and formalin. These samples were further concentrated to 20 to 30 ml by siphoning through 20 μ mesh. It will be later analysed in lab under microscope.

**Chlorophyll**: 3 liters of water was collected and filtered onboard using a GF/F filter paper and the filter papers were immediately stored in $-20^0$C for further analysis. Chlorophyll samples will be analysed by the standard protocol of Strikland and Parsons (1968).

**Mesozooplankton**: Zooplankton samples were preserved in formalin. Biomass estimation was done onboard by volume displacement method. Identification of zooplankton will be done in laboratory under microscope.

**Microbiology samples**: the samples were collected in 50 ml bottle and immediate stored in $-20^0$C.

***Cruise Track***



## *List of Participants*

| | | |
|---|---|---|
| Ms. Racheal Chacko | Chief Scientist | NCAOR, Goa |
| Dr. (Ms.) Sini Pavithran | Dy. Chief Scientist | NCAOR, Goa |
| Ms. Sharon Noronha | Research Fellow | NCAOR, Goa |
| Mr. Jenson George | Research Fellow | NCAOR, Goa |
| Mr. Manu Thambi | Research Fellow | NIO, Goa |
| Mr. Anand Joshi | Ph.D Student | JES College |
| Mr. Kalasadan Madhusudan | Service Engineer | NORINCO |
| Mr. T. Ramesh | Service Engineer | NORINCO |
| Mr. T. Baiju | Service Engineer | NORINCO |
| Mr. Karthikraja | Service Engineer | NORINCO |

***XBT Stations***

| S. No | Latitude | Longitude | Date | Time | SST (TSG) |
|---|---|---|---|---|---|
| 1 | 17 S | 65.25E | 26/11/2009 | 15:16 | 26.5 |
| 2 | 16S | 65.54E | 27/11/2009 | 04:40 | 27 |
| 3 | 15S | 66.00E | 27/11/2009 | 11:10 | 27 |
| 4 | 14S | 66.00E | 27/11/2009 | 17:27 | 28 |
| 5 | 13S | 66.15E | 27/11/2009 | 23:27 | 27.5 |
| 6 | 12S | 66.22E | 28/11/2009 | 06:00 | 27.5 |
| 7 | 11S | 66.28E | 28/11/2009 | 12:00 | 28.5 |
| 8 | 10S | 66.33E | 28/11/2009 | 18:00 | 28.5 |
| 9 | 9S | 66.45E | 29/11/2009 | 01.00 | 28.5 |
| 10 | 8S | 66.54E | 29/11/2009 | 07:00 | 28.5 |
| 11 | 7S | 66.58E | 29/11/2009 | 16:17 | 29 |
| 12 | 6S | 67.00E | 30/11/2009 | 00:25 | 29 |
| 13 | 5S | 67.00E | 30/11/2009 | 08.00 | 29 |
| 14 | 4S | 67.00E | 30/11/2009 | 16:16 | 29 |
| 15 | 3S | 67.19E | 30/11/2009 | 22:15 | 29 |
| 16 | 2S | 67.36E | 01/12/2009 | 04:14 | 28.5 |
| 17 | 1S | 67.52E | 01/12/2009 | 10:12 | 28.5 |
| 18 | 00 | 68.00E | 01/12/2009 | 20:00 | 29 |
| 19 | 1N | 68.15E | 02/12/2009 | 02:12 | 29 |
| 20 | 2N | 68.26E | 02/12/2009 | 08:10 | 29 |
| 21 | 3N | 68.39E | 02/12/2009 | 14:46 | 29.5 |
| 22 | 4N | 68.49E | 02/12/2009 | 20:57 | 29.5 |
| 23 | 5N | 69.00E | 03/12/2009 | 03:57 | 29.5 |
| 24 | 6N | 69.13E | 03/12/2009 | 11:37 | 29.5 |
| 25 | 7N | 69.29E | 03/12/2009 | 19:05 | 29.7 |
| 26 | 8N | 69.50E | 04/12/2009 | 02:35 | 29.7 |
| 27 | 9N | 70.12E | 04/12/2009 | 10.00 | 29.5 |
| 28 | 10N | 70.27E | 04/12/2009 | 18:00 | 29.5 |
| 29 | 11N | 70.42E | 05/12/2009 | 2:30 | 29.5 |
| 30 | 12N | 71.00E | 05/12/2009 | 11:43 | 29.3 |
| 31 | 13N | 71.16E | 05/12/2009 | 20:12 | 29.1 |
| 32 | 14_11N | 72.00E | 06/12/2009 | 09:00 | 29.00 |

## *Observation details*

| Stn No. | Date | Start Time (IST) | End Time | Latitude | Longitude (E) | Station Depth (m) | Instruments Operated |
|---|---|---|---|---|---|---|---|
| 1 | 07-11-2009 | 14:30 | 18:30 | 10 N | 65 | 4417 | SBE CTD, portable CTD,MPN, water sample collection |
| 2 | 08-11-2009 | 00:30 | 03:10 | 09 N | 65 | 4504 | SBE CTD, portable CTD |
| 3 | 08-11-2009 | 09:30 | 13:20 | 08 N | 65 | 4602 | SBE CTD, portable CTD,MPN, water sample collection |
| 4 | 08-11-2009 | 19:41 | 22:10 | 07 N | 65 | 4721 | SBE CTD, portable CTD |
| 5 | 09-11-2009 | 04:30 | 08:35 | 06 N | 65 | 4800 | SBE CTD, portable CTD,MPN, water sample collection |
| 6 | 09-11-2009 | 14:54 | 17:10 | 05 N | 65 | 4058 | SBE CTD, portable CTD |
| 7 | 10-11-2009 | 01:00 | 02:50 | 04 N | 65 | 3805 | SBE CTD, portable CTD, water sample collection |
| 8 | 10-11-2009 | 11:00 | 14:00 | 03 N | 65 | 2419 | SBE CTD, portable CTD |
| 9 | 10-11-2009 | 23:30 | 09:30 (11-11-2009) | 02 N | 65 | 3307 | Station skipped due to bad weather |
| 10 | 11-11-2009 | 18:30 | 22:00 | 01 N | 65 | 3673 | SBE CTD, portable CTD |
| 11 | 12-11-2009 | 06:15 | 10:45 | 00 | 65 | 3752 | SBE CTD, portable CTD,MPN, water sample collection |
| 12 | 12-11-2009 | 18:30 | 21:45 | 01 S | 65 | 3634 | SBE CTD, portable CTD |
| 13 | 13-11-2009 | 05:00 | 08:40 | 02 S | 65 | 4468 | SBE CTD, portable CTD, water sample collection |
| 14 | 13-11-2009 | 17:00 | 20:50 | 03 S | 65 | 3784 | SBE CTD, portable CTD |
| 15 | 14-11-2009 | 04:00 | 08:17 | 04 S | 65 | 4069 | SBE CTD, portable CTD,MPN, water sample collection |
| 16 | 14-11-2009 | 17:26 | 21:30 | 05 S | 65 | 4108 | SBE CTD, portable CTD |
| 17 | 15-11-2009 | 07:00 | 15:00 | 06 S | 65 | 3934 | SBE CTD, portable CTD, water sample collection |
| 18 | 16-11-2009 | 00:00 | 02:38 | 07 S | 65 | 4185 | SBE CTD, portable CTD |

| Stn No. | Date | Start Time (IST) | End Time | Latitude | Longitude (E) | Station Depth (m) | Instruments Operated |
|---|---|---|---|---|---|---|---|
| 19 | 16-11-2009 | 12:47 | 15:57 | 08 S | 66 | 4000 | SBE CTD, portable CTD,MPN, water sample collection |
| 20 | 16-11-2009 | 22:30 | 02:15 (17-11-2009) | 08 S | 65 | 3686 | SBE CTD, portable CTD,MPN, water sample collection |
| 21 | 17-11-2009 | 09:30 | 14:01 | 08 S | 64 | 4113 | SBE CTD, portable CTD,MPN, water sample collection |
| 22 | 17-11-2009 | 22:57 | 08:30 (18-11-2009) | 09 S | 65 | 4162 | SBE CTD, portable CTD,MPN, water sample collection |
| 23 | 18-11-2009 | 15:56 | 19:22 | 10 S | 66 | 3600 | SBE CTD, portable CTD,MPN, water sample collection |
| 24 | 19-11-2009 | 01:30 | 08:30 | 10 S | 65 | 4126 | SBE CTD, portable CTD,MPN, water sample collection, Idronaut CTD test |
| 25 | 19-11-2009 | 13:47 | 17:35 | 10 S | 64 | 3999 | SBE CTD, portable CTD,MPN, water sample collection |
| 26 | 20-11-2009 | 04:36 | 08:18 | 11 S | 65 | 4132 | SBE CTD, portable CTD,MPN, water sample collection |
| 27 | 20-11-2009 | 18:40 | 22:30 | 12 S | 66 | 3434 | SBE CTD, portable CTD,MPN, water sample collection |
| 28 | 21-11-2009 | 03:37 | 08:11 | 12 S | 65 | 3218 | SBE CTD, portable CTD,MPN, water sample collection |
| 29 | 21-11-2009 | 13:30 | 17:20 | 12 S | 64 | 4043 | SBE CTD, portable CTD,MPN, water sample collection |
| 30 | 22-11-2009 | 04:00 | 07:47 | 13 S | 65 | 3508 | SBE CTD, portable CTD, water sample collection |
| 31 | 22-11-2009 | 19:52 | 03:14 (23-11-2009) | 14 S | 66 | 3420 | SBE CTD, portable CTD,MPN, water sample collection |
| 32 | 23-11-2009 | 08:45 | 12:30 | 14 S | 65 | 3400 | SBE CTD, portable CTD,MPN, water sample collection |
| 33 | 23-11-2009 | 18:40 | 22:35 | 14 S | 63 | 3740 | SBE CTD, portable CTD,MPN, water sample collection |

| Stn No. | Date | Start Time (IST) | End Time | Latitude | Longitude (E) | Station Depth (m) | Instruments Operated |
|---|---|---|---|---|---|---|---|
| 34 | 24-11-2009 | 08:50 | 17:16 | 15 S | 65 | 3517 | SBE CTD, portable CTD,MPN, water sample collection |
| 35 | 25-11-2009 | 00:00 | 03:30 | 16 S | 65 | 3135 | SBE CTD, portable CTD,MPN, water sample collection |
| 36 | 25-11-2009 | 10:30 | 15:30 | 17 S | 65 | 3599 | SBE CTD, portable CTD,MPN, water sample collection |
| 37 | 25-11-2009 | 23:00 | 06:00 (26-11-2009) | 18 S | 65 | 3771 | SBE CTD, portable CTD,MPN, water sample collection |
| 38 | 26-11-2009 | 23:30 | 04:30 (27-11-2009) | 16 S | 66 | 2726 | SBE CTD, portable CTD,MPN, water sample collection |
| 39 | 29-11-2009 | 14:00 | 16:05 | 07 S | 67 | 3489 | SBE CTD, portable CTD,MPN, water sample collection |
| 40 | 29-11-2009 | 22:00 | 00:05 (30-11-2009) | 06 S | 67 | 3319 | SBE CTD, portable CTD,MPN, water sample collection |
| 41 | 30-11-2009 | 06:00 | 07:35 | 05 S | 67 | 3942 | SBE CTD, portable CTD,MPN, water sample collection |
| 42 | 30-11-2009 | 13:00 | 16:00 | 04 s | 67 | 3532 | SBE CTD, portable CTD,MPN, SVP, water sample collection |