ORV SAGAR KANYA

SK-249 Cruise

(27th Aug to 19th Sept 2008)

'Multibeam Swath Bathymetric Survey Off-Lakshadweep Islands under Indian EEZ Programme'

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Headland Sada, Vasco-da-gama (Goa)

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1. INTRODUCTION

India has a coastal line of 7516 km and an Exclusive Economic Zone (EEZ) of about 2.02 million square kilometers. Indian EEZ has many economic resources such as minerals, hydrocarbons etc. The knowledge of sea floor topography is essential for ocean resources management activities and planning. Most of the our knowledge about the seafloor topography is limited to single beam echo sounding data collected by different ships in the last couple of decades.

Ministry of Earth Sciences (MoES) planned and included the EEZ surveys in 11th 5-year plan to map the entire EEZ of India. National Centre for Antarctic and Ocean Research (NCAOR), Goa is a nodal agency for implementing the programme and National Institute of Oceanography (NIO), Goa and National Institute of Ocean Technology (NIOT), Chennai are partners in this programme.

The First Multibeam Swath bathymetric Survey was carried out jointly by NCAOR & NIO onboard ORV-Sagar Kanya (SK-218 cruise) off-Andaman area and one block was completed. NCAOR carried out four independent cruises for Multibeam Swath bathymetric Survey. Three cruises were carried out in Bay of Bengal and one in Arabian Sea. Three EEZ surveys were carried out by using Atlas Hydrosweep system onboard ORV-Sagar Kanya and Atlas Hydrosweep DS2 system onboard RV-Akademik Boris Petrov and one cruise was undertaken recently onboard ORV-Sagar Kanya utilizing the recently installed Seabeam 3012 Multibeam echosounder.

Seabeam 3012 swath bathymetric multibeam echosounder system was installed onboard ORV-Sagar Kanya in 2006 and successful sea-trials were done in SK-245 cruise. After successful sea-trials of Seabeam 3012, first Multibeam survey cruise was undertaken in Bay of Bengal EEZ. The present cruise is second scheduled survey off- Lakshadweep islands under the Indian EEZ survey programme.

2. OBJECTIVES

The main objective of the cruise is to survey and prepare a comprehensive topographic map for the survey area as a part of the Survey of the entire EEZ of the country under EEZ survey project. Apart from above, sediment and water sampling shall also be carried out for Dept. of Civil Engineering, SDM College of Engineering and Technology, Dharwad under MoES project entitled: Surf zone dynamics and near shore sedimentation process between the coast Bhatkal and Baindur.

3. CRUISE ITINERARY

Vessel sailed from Mormugao Port at 1600 hrs on 27th Aug 2008 for Sediment and water sampling for SDM College of Engg. & Tech., Dharwad and then shall proceed for EEZ surveys.

Departure	:	Mormugao	27th Aug 2008
Arrival	:	Mormugao	19th Sept 2008

4. PARTICIPANTS

A total of ten scientific personnel participated in the cruise. The scientific team comprised of a scientist from NCAOR, one Research scholar from SDM College (Dharwar), six NORINCO engineers and two shipboard

assistants. The ship's complement was 49, bringing the total for the present cruise to 59.

4.1 Scientific Complement

NCAOR

1. **Abhishek Tyagi** **- Chief Scientist**
2. Krishnaprasad Palthady Ananda

NORINCO

3. Kalasadan Madhusudan
4. Narayanan Dhanasekaran
5. Jeyaraj Vishwanathan
6. Karuppiah Arulvalar Selvam
7. Manoharan Krishna Raja P.
8. Madar Parshuram Durgappa

NCAOR SHIPBOARD ASSISTANTS

9. Bamania Manish Virchand
10. Tandel Dipeshkumar Vithalbhai

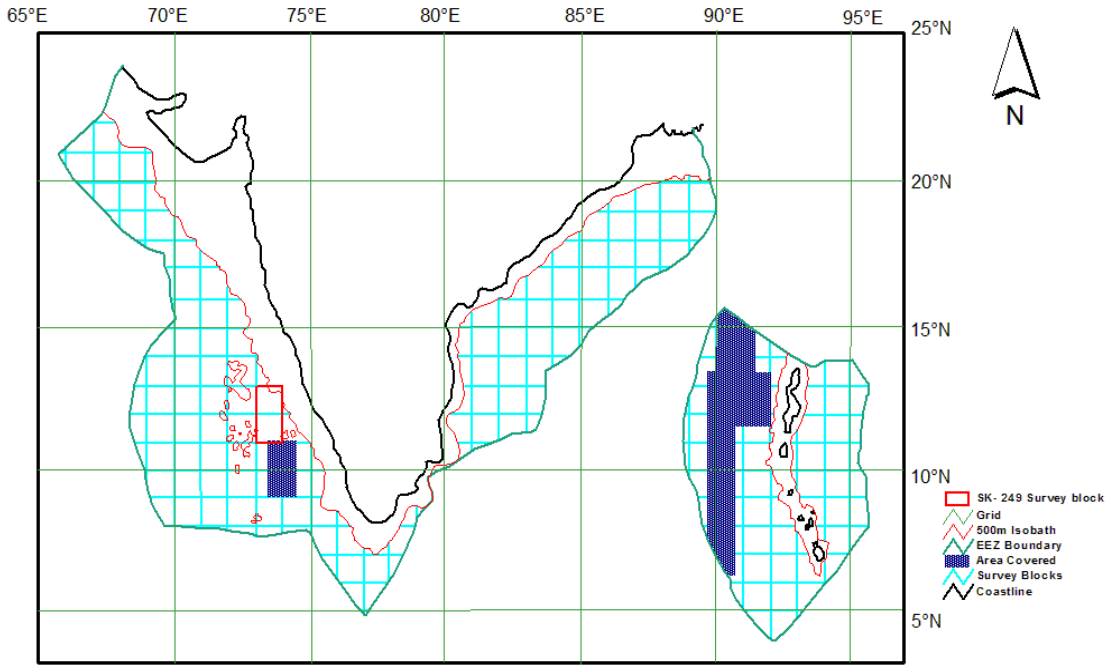
4.2 Ship's Complement

S. No.	Name	Rank
1.	Capt. Kulandai Samy Pandian	Master
2.	Ajay Sharma	Ch.Off.
3.	Abdul Hameed Yusuf Kazi	2nd Off.
4.	Constancio Monteiro	Rd/Off.
5.	Dr. Piyush Kumar	Med.Off.
6.	Rommel Gregorio S. D'Silva	Purser
7.	C.N. Sasidharan	Ch.E/Off.
8.	Jibanando Sarkar	2/E/Off.
9.	Dhananjay Kumar	A/2EO
10.	Gunna Ramakrishna Rao	4/E/Off.
11.	Goutam Mistry	Elect. Off.
12.	Sandeep Kumar Sethi	Electr.Off.
13.	Norman Joseph Dias	CTO
14.	P. Jayakumar	ERPO3
15.	John N. Joseph	POM
16.	Subash Vishwakarma	POM
17.	Saud Hussainmiiya Hodekar	C/C/Bkr.

5. AREA OF OPERATION

Present cruise was planned off-Lakhsadweep islands in the northern block of previously surveyed block. The Block coordinates of the area are:

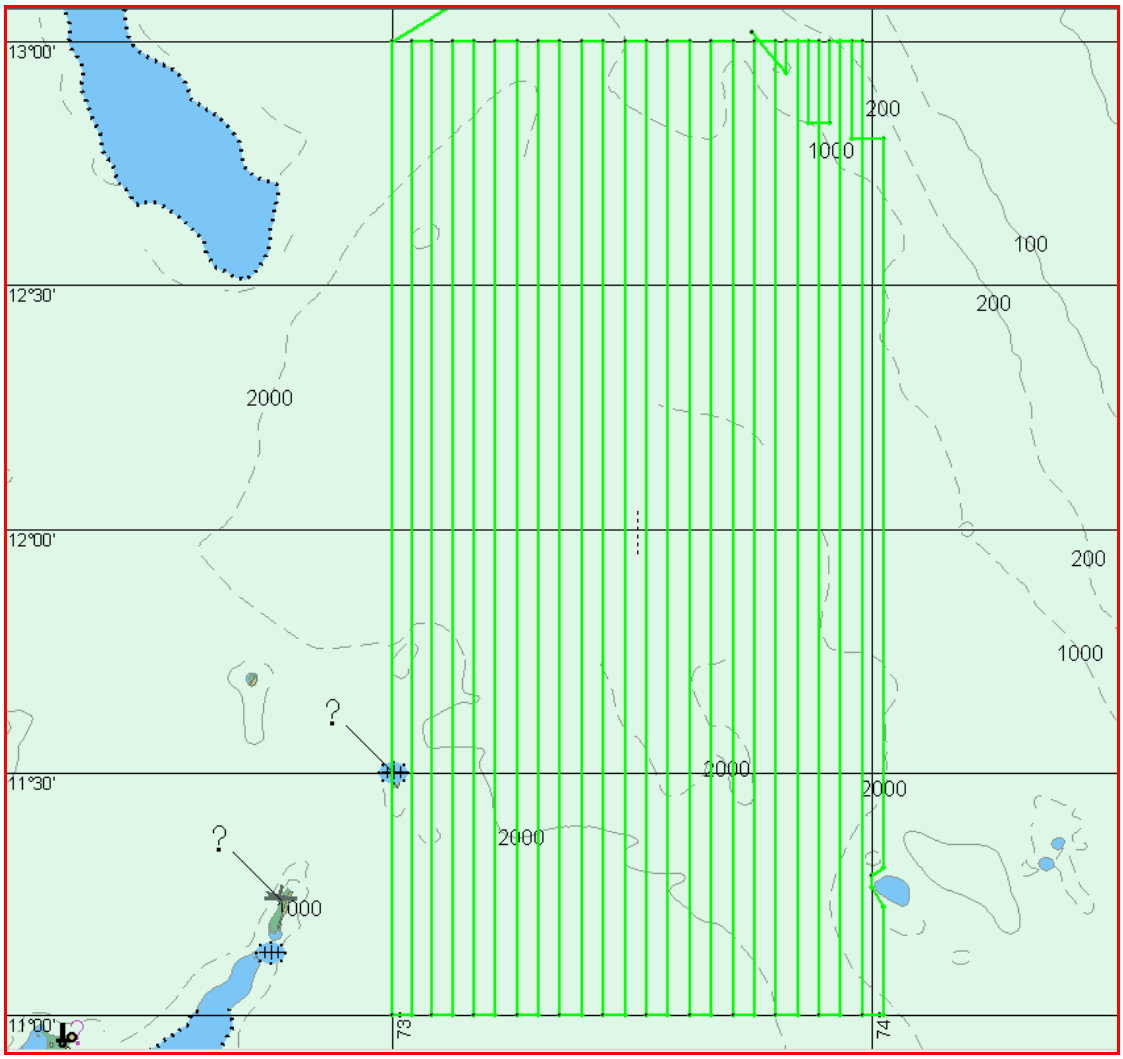
Latitude : 11° 00′ N to 13° 00′ N
Longitude : 73° 00′ E to 74° 00′ E



Survey block (SK-249 cruise)- 11° - 13° N, 73° - 74° E

Survey Block

The Total Block size is 2 deg X 1 deg and it is around 25000 Sq. km. Initially 23 survey lines were planned to be covered, but the survey was carried out along the 24 track lines. Total 5340 line km data was collected and area of around 25,000 Sq Km was surveyed in the present cruise.



Survey Track Lines of the Area

6. SURVEY EQUIPMENTS

SB-3012 Multibeam Echosounder System:

SeaBeam 3012 Multibeam Echosounder onboard ORV-Sagar Kanya was used to carry out the present surveys. The specifications of the system are as follows:

Make	: L3-Communications Elac-Nautik
No. of beams	: 201
Swath coverage	: 5 x Water Column
Frequency of operation	: 12 KHz
Technology	: Full motion compensation (Sweptbeam technology)
Depth performance	: Max. 11,000 m.
Acquisition software	: Hydrostar

Data Processing software: Eiva NaviPac

The SB3012 is a 12 KHz, 201 beam sonar system, with an effective 150^0 of swath. The system has a beam width of 1 degree at nadir and is capable of depths 200 metres to 11000 metres.

The swath coverage depends upon the beam angles. The beam angle will be a minimum of 90 degrees in the depth range of 4000 m and beyond. Multi beam system provides full swath coverage with minimum beam angle. The beam angle and water depth are as:

Depth (m)	**Beam Angle (°)**
200 - 500	≈ 150 (Max)
500 – 1500	≈ 145
1500 - 2700	≈ 140
>4000	≈ 90

The Multibeam system complex comprises of many sub systems:

- **Surface Sound velocity (SSV**):

The surface sound velocity profiler is an underway ocean profiling system that can collect the water sound speed profiles while the vessel is still in motion

- **Side Scan Imagery Printer**

Online printer provided with system and annotation interval was set at 30 minutes.

- **Gyro and Motion sensor:**

MB system uses Octans sensor for Gyro and motion input. Octans is an IMO-compliant survey-grade gyrocompass with an integral motion sensor.

Gyrocompass Technical Performance

Dynamic accuracy (independent of sea state): ±0.2° Secant lat. or 0.1° Rms
Settle point error: ±0.1° Secant latitude or 0.05° Rms
Settling time (static conditions): 1 minute
Settling time at sea: 3 minutes
Repeatability: ±0.025° Secant latitude
Resolution: 0.01°
No latitude limitation
No speed limitation

Motion Sensor Technical Performance

Heave, Surge & Sway:

Accuracy 5 cm or 5% (whatever is higher)
Resolution 1 cm
Heave motion periods 0.03 to 100 s (tuneable)

Roll, Pitch & Yaw:

Accuracy 0.01°
Range No limitation
Follow up speed Up to 500 ° /s

- **Positioning System**

C-NAV DGPS subsystem is used for positioning accuracy. C-Nav GcGPS corrections are similar to other wide area DGPS system such as the Federal Aviation Administration's (FDA) wide area augmentation system (WAAS). The C-Nav GPS receiver can accept two (2) different GcGPS correction service message formats.

The C-Nav, dual frequency, GPS user equipment receives either of these corrections broadcast from the communications satellite, applies them its own observed, refraction corrected C/A code, dual frequency observations, and performs a navigation solution. The resulting corrected GPS position; velocity and time (PVT) are output from the C-Nav equipment to other subsystems on the platform/vehicle/vessel to support the navigation positioning control requirements.

- **Network Timeserver with GPS synchronized time base**

LANTIME (local area network timeserver) provides a high precision time base to a TCP/IP network (stratum-1-server). The NTP (network time protocol) is used to synchronize all NTP clients with the reference.

LANTIME/GPS is a set of equipment composed of a satellite controlled clock GPS167, a single-board computer with integrated network board and a power supply, all installed in a metal 19" on the single-board computer flash disk. Four push buttons and a 2 x 40 character LC display can be used configure and monitor the time server. After the network

connection has been bestialized the time server can also be configured and monitored remotely from a workstation via TELNET or FTP.

- **Network Time Protocol (NTP)**

NTP is a common method for synchronization of hardware clocks in local and global networks.

Timeservers synchronize themselves by a reference time source, such as a radio controlled clock, GPS-receiver or modem time distribution. Stratum-1-servers distribute their time to several clients in the network which are called stratum-2.

A high precision synchronization is feasible because of the several time references. Every computer synchronizes itself buy up to three valued time sources. NTP enables the comparison of the hardware times and the adjustment of the own clock, a time precision of 128ms, often better than 50ms, is possible.

- **Sound Velocity Profiler (SVP**)

MIDAS SVP Sound Velocity Profiler was used to measure the sound velocity profile. Its uses the advanced digital signal processing technique that removes virtually all noise from the data. The sound pulse is both transmitted and received, and allows to measure the time of flight with a resolution of 1/100th of a nanosecond (10^{-11} seconds).

The unit is fitted with the sound velocity, pressure and temperature sensors:

Sound Velocity

Type	: Valeport “time of flight” SV sensor
Range	: 1400 to 1600m/s standard.
Accuracy	: ±0.03m/s
Resolution	**:** 0.001m/s

Pressure

Type	: Temperature Compensated Piezo-Resistive Sensor
Range	: 600Bar absolute (approx 6000m water depth).
Precision	: ±0.01% Full scale (±0.6m with a 600Bar sensor)
Resolution	: 0.001% Full scale (0.06m with a 600 Bar sensor)

Temperature

Type	: Fast response PRT
Range	: -5 to +35°C
Accuracy	: ± 0.01°C
Resolution	: 0.002°C

- **Data Acquisition Software:**

Sun workstation is the operator control station and Hydrostar the operator control station software. Sun workstation performs all commands to operate the SeaBeam 3012 system. Hydro star is a data acquisition and control system for Multibeam sonar. It also acts as an interface for various external sensors (position, motion, heading and sound velocity sensors).

NaviPac software used for navigation and data acquisition from various feeds such as GPS, Gyro, Motion sensor etc. NaviPac also allows the navigator to perform all phases of surface, sub-sea and remote navigation, to view all sensor data, to perform changes in navigation principles and components. The programme reads all basic information from the setup DB, present all available stations and let the navigator specify the stations wanted. All the information's is stored in the online DB file, which can be maintained by one or more online programs. NaviPac is installed in Windows NT workstation.

NaviEdit, NaviModel and NaviPlot are the software to edit the data and create the model and plot the final chart.

7. OTHER EQUIPMENTS

Apart from the swath bathymetric Multibeam system many other types of equipment were used to collect the additional supporting data in the survey area. The main equipments used during the cruise are:

Sub Bottom Profiler

GeoAcoustics Sub bottom profiler onboard was used to collect the sub bottom profile data. SBP contains four units:

- GeoPro data processing unit: It is the main processing unit and MacOS is the operating system. GeoPro software, which is a complete software system, installed in the main unit and software features, such as acquisition, target analysis, mosaicing and seismic processing are all part of one software application.
- GeoPulse 5430A Transmitter: It is a stand-alone transmitter of 10 kW maximum power output in a frequency range of 2 KHz to 12 K HZ.
- GeoPulse Receiver: The receiver is a universal amplifier/filter for use in sub bottom profiling. The receiver, combining many functions, replaces many single function boxes that would otherwise create space as well as interference problems.
- Sidescan Sonar: It is the unit for side scan sonar operation.

Single Beam Echosounder

Shallow water and Deep water Echosounder onboard provided the water depth. The data was collected throughout the cruise along the survey track and towards the journey periods.

- **ELAC VE 4900**: This is the deep water single beam Echosounder system capable to measure the depth up to the 10,000 m. There are two single frequency hull mounted transducers of 12 KHz for depths more than 3000 m and 30 KHz for depth up to 3000 m.
- **Marimatech E-SeaSound 206**: It is a shallow water survey Echosounder for depths up to 1200 m. This is dual frequency 60/ 120 KHz system. The transducers are fitted one at forward and one at aft and each has a dual frequency 60 and 120 KHz. It is equipped with an in-built thermal printer to print the online images**.**

CTD: Idronaut CTD and rosette water samples bottles were used to collect the CTD data and water samples. At one station both Idronaut as well as SBE Portable CTD cast was taken By attaching PCTD to Idronaut CTD frame.

ADCP: Acoustic Doppler Current Profiler data was collected all along the ship track.

Sediment Samplers: Gravity corer and Grab sampler were used for sediment sampling.

8. SURVEY METHODOLOGY

The use of Multibeam sonar for accuracy-critical applications has become widespread. Along with the adoption of the Multibeam as the instrument of choice for most hydrographic applications, the occurrence of associated errors has been minimized.

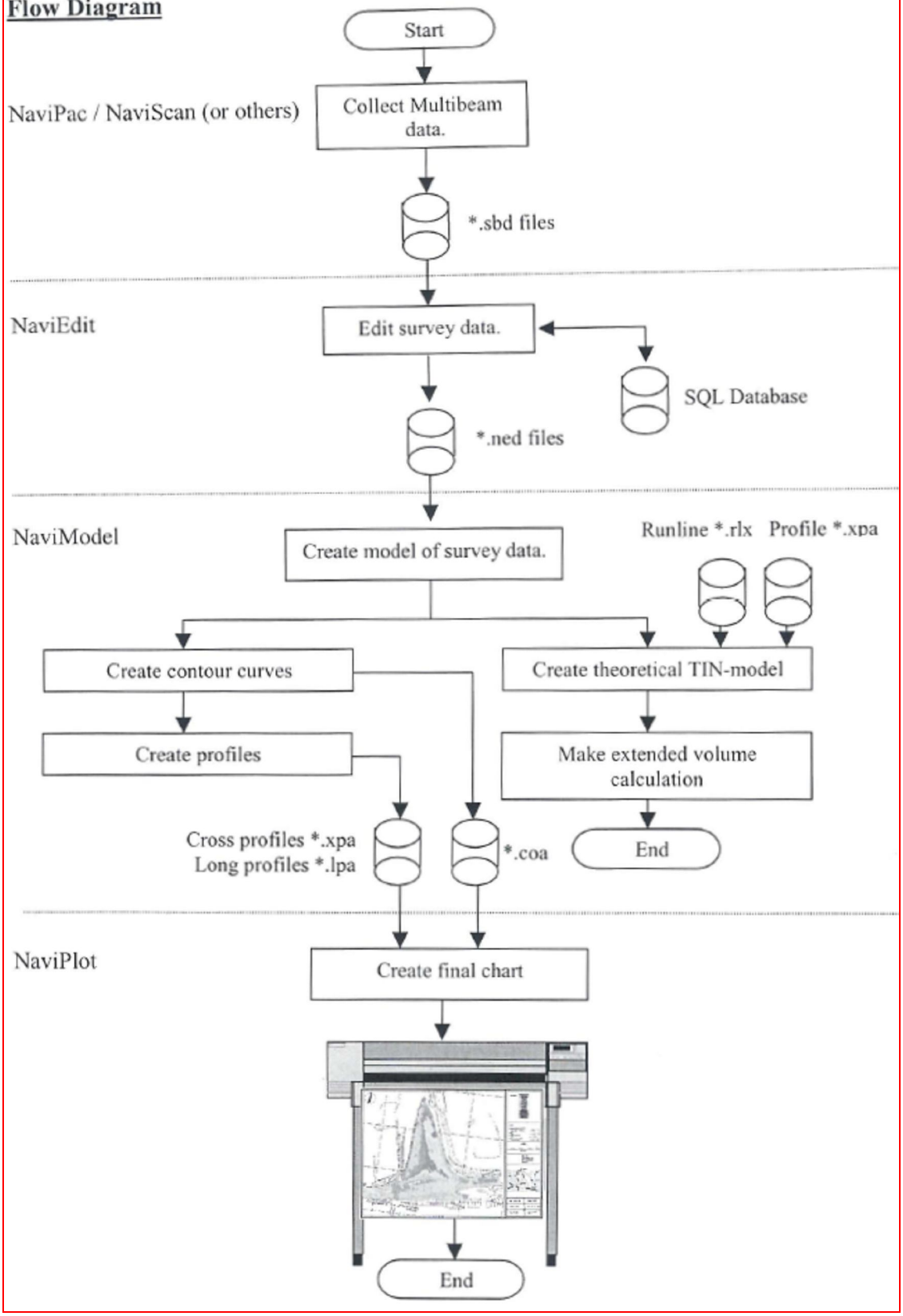
Multibeam survey was carried out using standard practice. The lines have been run in order to obtain 20% coverage at maximum speed of 9 knots. Lines are run in order to paint the area by following the outer beams of previous lines.

Navigational and attitude information is provided by C-NAV DGPS system. Ship track was well maintained within ±10 m.

The surface sound velocity was directly measured by SB 3012 system. The surface sound velocity was recorded to be approximately 1541 m/s over the duration of the survey.

The flow chat for SB3012 is shown as follows:

Flow Diagram



9. DATA COLLECTION AND PRESENTATION

- **Multibeam Data**

Multibeam sonar data was collected by SB3012 system. Side Scan images were also printed online with the annotation interval of 30 minutes. A total of around 5340 line Km data was collected along the 24 track lines, covering an area of 25000 sq km. The Multibeam data collection details are given in the table.

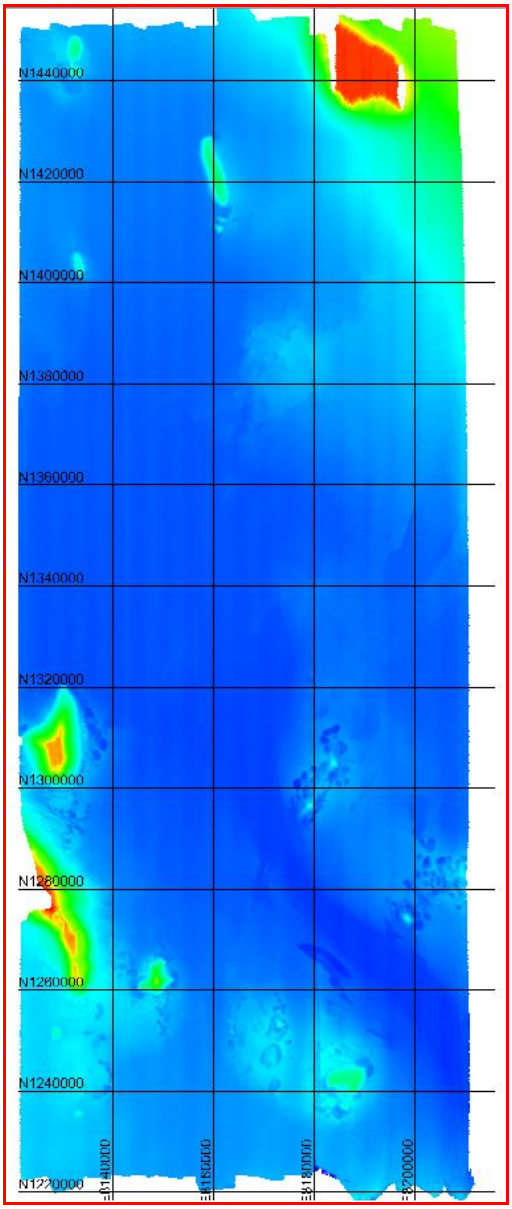
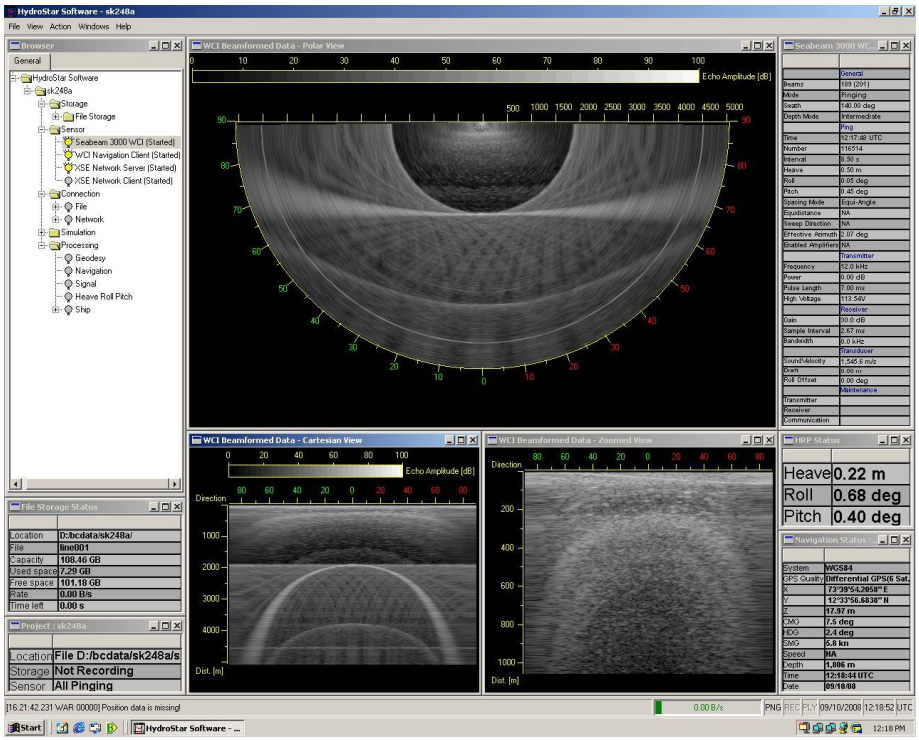


Fig. Colour coded bathymetric map of survey area

- **Water Column Imaging**

Water Column Imaging was operational and was continuously monitored all throughout the cruise for QC of Multibeam data.



- **Side Scan Images**

The side scan images were continuously monitored and printed with online thermal printers. In the survey area many seabed features were seen.

- **Sound velocity Profile**

The structure of the water column in Bay of Bengal is a major concern, as the influx of fresh water causes a major variation of sound differential in the top layers of the water column. The top 200 m was constantly changing. However, below this depth, the speed of sound remained relatively constant reflecting the more stable water mass below this depth. Sound velocity profiler casting was carried out in 12 stations. All the data

was analysed and temperature and sound velocities were plotted with the water depth.

- **Sub-bottom Profiler Data**:

  Sub-bottom profiler data was collected to understand the sea bottom. The data was collected beginning just after vessel sailed from Mormugao throughout the entire cruise and also during the return passage.

- **Single Beam Echosounder Data**:

  12 KHz data of Deep water single beam Echosounder was collected along the ship's track in the survey area. Data was also collected along both the outward and return passage track.

- **CTD Data and water samples:**

  Water samples were collected at 11 CTD stations using rosettes sampler. All samples were preserved in Cold store onboard and will be transported after the cruise for further laboratory analysis at SDM College, Dharwar.

- **Sea Surface Temperature and Atmospheric Pressure Data**

  Sea Surface Temperature (SST) and atmospheric pressure data was recorded at 3 hourly intervals. The data collection commenced as vessel sailed out from Mormugao and up to the arrival of vessel at Mormugao after completion of the cruise.

10. WORKS ACCOMPLISHED

The cruise was successfully completed and survey was carried out along 24 track lines. A total of 5340line km bathymetric data was collected and a total of around 25,000 sq. km. area was surveyed. The CTD was operated at 10 stations and water samples at all ten stations were also

collected. Sediment samples were also collected by operating Gravity corer at 7 locations and Grab sampler at 20 locations.

The survey was the integral part of the Indian EEZ survey programme and data collected during the cruise will contribute to better understanding and mapping of the entire Indian EEZ.

11. DIARY OF EVENTS

27.08.2008: All the scientists embarked onboard at 1200hrs and the Vessel sailed out for scientific operations from Mormugao Port at 1600hrs. Vessel sailing for gravity coring location No. SDM/GC-01.

Gravity corer operated at Stn. No. SDM/GC-01 at 2340hrs, POSN: 73^{o} 55.07' E; 14^{o} 25.05' E, Depth – 47.5 m (DBK-Depth Below Keel), Recovery – 0.5m. Proceeding for Stn. No. SDM/GC-02.

28.08.2008: POSN at 0800hrs- 13° 52.05' N; 74° 24.4' E, SST- 26°C, Atm. Pr.- 1011.5mb, Depth- 24m, Ship Speed- 0.3 kts

Gravity corer operated at Stn. No. SDM/GC-02 at 0540hrs, POSN: 13° 52.21' N; 74° 22.82' E, Depth- 29.4m (DBK), Recovery- 2.89m. Gravity corer steel pipe bent during operation, was replaced for next operations. Proceeding to Grab-Water (G/W) sampling station no. 2.

CTD and Water samples collected at Stn. No. 2, Posn- 13° 51.32' N; 74° 23.39' E, Depth- 30 m at 0730hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 3, Posn- 13° 52.43' N; 74° 24.56' E, Depth- 26m at 0820hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 4, Posn- 13° 52.14' N; 74° 25.61' E, Depth- 24m at 0915hrs. CTD & Water sampling cast at same stn. completed at 0944hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 5, Posn- 13° 52.50' N; 74° 27.40' E, Depth- 20m at 1025hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 6, Posn- 13° 52.58' N; 74° 23.36' E, Depth- 18m at 1057hrs. CTD & Water sampling cast at same stn. completed at 1150hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 7, Posn- 13° 52.47' N; 74° 29.02' E, Depth- 16m at 1225hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 16, Posn- 13° 51.50' N; 74° 27.75' E, Depth- 20m at 1310hrs. CTD & Water sampling cast at same stn. completed at 1345hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 1, Posn- 13° 51.95' N; 74° 26.51' E, Depth- 21m at 1430hrs. CTD & Water sampling cast at same stn. completed at 1450hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 15, Posn- 13° 50.80 N; 74° 26.49' E, Depth- 22m at 1530hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 9, Posn- 13° 51.61' N; 74° 23.69' E, Depth- 28m at 1630hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 10, Posn- 13° 49.41' N; 74° 23.79' E, Depth- 30m at 1700hrs. CTD & Water sampling cast at same stn. completed at 1720hrs/28.08.2008. Proceeding to next Stn.

CTD & Water sampling cast at Stn. No. 14, Posn- 13° 49.24' N; 74° 26.28' E, Depth- 25m at 1825hrs. Grab sample collected at same stn. completed at 1835hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 17, Posn- 13° 49.60' N; 74° 28.19' E, Depth- 20m at 1930hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 18, Posn- 13° 46.64' N; 74° 28.95' E, Depth- 21m at 2037hrs. CTD & Water sampling cast at same stn. completed at 2048hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 19, Posn- 13° 45.08' N; 74° 29.01' E, Depth- 22m at 2148hrs/28.08.2008. Proceeding to next Stn.

Grab sample collected at Stn. No. 13, Posn- 13° 46.83' N; 74° 26.63' E, Depth- 25m at 2235hrs/28.08.2008. Proceeding to next Stn.

29.08.2008: POSN at 0800hrs- 13° 36.3' N; 74° 01.6' E, SST- 27.5°C, Atm. Pr.- 1011.5mb, Depth- 636m, Ship Speed- 10.3 kts.

Grab sample collected at Stn. No. 12, Posn- 13° 46.01' N; 74° 23.81' E, Depth- 31m at 2335hrs. CTD & Water sampling cast at same stn. completed at 0000hrs/29.08.08. Proceeding to next Stn.

Grab sample collected at Stn. No. 11, Posn- 13° 47.06' N; 74° 23.81' E, Depth- 30m at 0035hrs/29.08.08. Proceeding to next Stn.

Grab sample collected at Stn. No. 8, Posn- 13° 51.50' N; 74° 10.00' E, Depth- 42m at 0225hrs. CTD & Water sampling cast at same stn. completed at 0250hrs/29.08.08. Proceeding to next Stn.

Grab sample collected at Stn. No. 21, Posn- 13° 44.97' N; 74° 09.91' E, Depth- 45m at 0415hrs/29.08.08. Proceeding to next Stn.

Grab sample collected at Stn. No. 20, Posn- 13° 40.06' N; 74° 10.00' E, Depth- 46m at 0520hrs. CTD & Water sampling cast at same stn. completed at 0600hrs/29.08.08. Proceeding to next Stn.

Gravity corer operated at Stn. No. SDM/GC-03 at 0715hrs, POSN: 13° 40.00' N; 74° 07.96' E, Depth- 48m (DBK), Recovery- 4.82 m.
Proceeding to Survey area, Heading 13° N; 73° E.

30.08.2008: POSN at 0800hrs- 11° 08.8' N; 73°E, SST- 27°C, Atm. Pr.- 1011.5mb, Depth- 1803m, Ship Speed- 9 kts, Sky overcast-intermittent rains.

Reached BOL-1. Operated Gravity corer and SVP cast.
Gravity corer operated at Stn. No. EEZ/GC-01 at 1500hrs/29.08.08, POSN: 12° 59.92' N; 72° 59.97' E, Depth- 1894m (DBK), Recovery- 3.48m.

Started survey, Begining of line (BOL)-1 at ~1900hrs/29.08.08.

End of Line (EOL)-1 at 0900hrs/30.08.08.

Vessel stopped for Gravity Croing operation and SVP cast.
Gravity corer operated at Stn. No. EEZ/GC-02 at 1000hrs, POSN: 11° 02.1070' N; 72° 58.4005' E, Depth- 1875m (DBK), Recovery- 1.93m.

SVP cast and Begining of line (BOL)-2 at 0724gmt/30.08.08, 73°02.30'E; 11°N, speed- 8.4knots, D=1852m.

End of Line (EOL)-2 at 2207gmt/30.08.08, 73°02.27'E; 13°N, speed- 2knots, D=1927m.

31.08.2008: POSN at 0800hrs- 12° 40.26' N; 73° 05'E, SST- 27.5°C, Atm. Pr.- 1011.5mb, Depth- 2024m, Ship Speed- 9 kts, Clouds scattered, seastate 2-3.

SVP cast and Begining of line (BOL)-3 at 0015gmt/31.08.08, 73°04.56'E; 13°N, speed- 8.2knots, D=1940m.

End of Line (EOL)-3 at 1400gmt/31.08.08, 73°05'E; 11°N, speed- 8.4knots, D=1899m.

SVP cast and Begining of line (BOL)-4 at 1610gmt/31.08.08, 73°07.29'E; 11°N, speed- 7.4knots, D=1923m.

01.09.2008: POSN at 0800hrs- 12° 30.90' N; 73° 07.56'E, SST- 27.5°C, Atm. Pr.- 1011.5mb, Depth- 2060m, Ship Speed- 8.8 kts, Clouds scattered, seastate 2, mild breeze.

End of Line (EOL)-4 at 0550gmt/01.09.08, 73°07.29'E; 13°N, speed- 6.5knots, D=1938m.

SVP cast and Begining of line (BOL)-5 at 0954gmt/01.09.08, 73°10'16"E; 13°N, speed- 6.4knots, D=1938m.

End of Line (EOL)-5 at 2330gmt/01.09.08, 73°10'11"E; 11°N, speed- 8.5knots, D=1945m.

02.09.2008: POSN at 0800hrs- 11° 07.15' N; 73° 12.81'E, SST- 27.5°C, Atm. Pr.- 1011.5mb, Depth- 2023m, Ship Speed- 8.8 kts, Clouds scattered, seastate 2.

SVP cast and Begining of line (BOL)-6 at 0130gmt/02.09.08, 73°12'21"E; 11°N, speed- 8.4knots, D=1950m.

End of Line (EOL)-6 at 1505gmt/02.09.08, 73°12'52"E; 13°00'18"N, speed- 4.7knots, D=1937m.

SVP cast and Begining of line (BOL)-7 at 1712gmt/02.09.08, 73°15'42"E; 13°N, speed- 7.1knots, D=1928m.

03.09.2008: POSN at 0800hrs- 11° 37.51' N; 73° 15.61'E, SST- 28°C, Atm. Pr.- 1009.5mb, Depth- 2017m, Ship Speed- 9.2 kts, Clouds scattered, seastate 2.

End of Line (EOL)-7 at 0646gmt/03.09.08, 73°15'36"E; 11°N, speed- 8.8knots, D=1977m.

SVP cast underway at 73°18'31"E; 10°58'13"N, shall procced to Begining of line (BOL)-8 on completion of SVP cast.

SVP cast and Begining of line (BOL)-8 at 1100gmt/03.09.08, 73°18'18.7"E; 11°N, speed- 9.0knots, D=1962m.

04.09.2008: POSN at 0800hrs- 12° 58.90' N; 73° 21'E, SST- 28°C, Atm. Pr.- 1011.5mb, Depth- 2006m, Ship Speed- 9.1 kts, sky overcast, seastate 2.

End of Line (EOL)-8 at 0017gmt/04.09.08, 73°18'18.7"E; 13°N, speed- 8.1knots, D=1880m.

SVP cast and Begining of line (BOL)-9 at 0222gmt/04.09.08, 73°21"E; 13°N, speed- 8.7knots, D=1823m.

End of Line (EOL)-9 at 1812gmt/04.09.08, 73°20'59"E; 10°59'N, speed- 4.3knots, D=1932m.

SB3012 system stopped pinging/hanged in afternoon/04.09.08, and had to be restarted to resume pinging. Portion of the track-Line re-surveyed to cover gap. Problem reported to OEM, alongwith other problems faced in the current cruise.

SVP cast and Begining of line (BOL)-10 at 2000gmt/04.09.08, 73°22'29"E; 10°59'29"N, speed- 7.6knots, D=1930m.

05.09.2008: POSN at 0800hrs- 11° 52.20' N; 73° 23.58'E, SST- 28°C, Atm. Pr.- 1012.5mb, Depth- 2120m, Ship Speed- 8.9 kts, sky overcast, seastate 2.

End of Line (EOL)-10 at 1000gmt/05.09.08, 73°23'41"E; 13° 01'N, speed- 1.2knots, D=1721m.

SVP cast and Begining of line (BOL)-11 at 1206gmt/05.09.08, 73°26'24"E; 13°00'20"N, speed- 7.8knots, D=1676m.

06.09.2008: POSN at 0800hrs- 11° N; 73° 26.43'E, SST- 28°C, Atm. Pr.- 1012.5mb, Depth- 1932m, Ship Speed- 0.2 kts, scattered clouds, seastate 2.

End of Line (EOL)-11 at 0138gmt/06.09.08, 73°26'23"E; 11°N, speed- 6.4knots, D=1929m.

SVP cast at 0820hrs LT at POSN: 11°N; 73 26.4'E. Proceeding to BOL-12.

At around 0900 hrs LT smoke was noticed in the propulsion motor room, and vessel halted to rectify/repairs. Partial PM power restored at 1225hrs LT and vessel started proceeding to BOL-12 for resuming surveys. Propulsion only by Portside Propulsion motors (PM No. 1 & 2). Vessel Speed around 8knots.

Surveys resumed at BOl-12 on 1320hrs LT. SVP cast and Begining of line (BOL)-12 at 0750gmt/06.09.08, 73°26'24"E; 13°00'20"N, speed- 7.8knots, D=1676m.

07.09.2008: POSN at 0800hrs- 11°36.91'N; 73° 29.12'E, SST- 28°C, Atm. Pr.- 1012.5mb, Depth- 2107m, Ship Speed- 7.6 kts, Intermittent Rains, sky overcast, seastate 2-3.

L-12 stopped at 11°20'N and carried out patch survey for previous lines to minimise time usage for patch survey. Resumed L-12 at 0052gmt/07.09.08.

Vessel halted for repairs/trials of the Starboardside Propulsion Motors at 0400gmt/07.09.08 and started at 0510gmt. PM problem could not be rectified. Propulsion only by Portside Motors (i.e. PM-1 & 2).

Resumed Surveys. End of Line (EOL)-12 at 1400gmt/07.09.08, 73°29'06"E; 13°N, speed- 8.9knots, D=1024m.

SVP cast and Begining of line (BOL)-13 at 1524gmt/07.09.08, 73°31'48"E; 13°N, speed- 6.8knots, D=293m.

08.09.2008: POSN at 0800hrs- 11°36.51'N; 73° 31.86'E, SST- 28°C, Atm. Pr.- 1012.5mb, Depth- 2004m, Ship Speed- 7.6 kts, moderate Rains, sky overcast, seastate 3.

End of Line (EOL)-13 at 0720gmt/08.09.08, 73°31'41"E; 10°59'N, speed- 6.3knots, D=1916m.

No SVP cast due to heavy rains and strong wind, Begining of line (BOL)-14 at 0800gmt/08.09.08, 73°33'28"E; 10°59'N, speed- 6.7knots, D=1894m.

09.09.2008: POSN at 0800hrs- 13°N; 73°34.40'E, SST- 28°C, Atm. Pr.- 1011.5mb, Depth- 1046m, Ship Speed- 7.2 kts, Drizzle, sky overcast, seastate 3-4.

End of Line (EOL)-14 at 0150gmt/09.09.08, 73°34'29"E; 13°N, speed- 6.5knots, D=1046m.

SVP cast and Begining of line (BOL)-15 at 0345gmt/09.09.08, 73°37.19'E; 12°59'49"N, speed- 6.9knots, D=1051m.

End of Line (EOL)-15 at 2012gmt/09.09.08, 73°37'11"E; 11°N, speed- 7.4knots, D=1922m.

No SVP cast due to bad weather, Begining of line (BOL)-16 at 2100gmt/09.09.08, 73°39'55"E; 11°N, speed- 6.0knots, D=1934m.

10.09.2008: POSN at 0800hrs- 11°32.80'N; 73°39.80'E, SST- 28°C, Atm. Pr.- 1011.5mb, Depth- 1993m, Ship Speed- 6.2 kts, Intermittent rains, sky overcast, seastate 4-5.

End of Line (EOL)-16 at 1630gmt/10.09.08, 73°39'52"E; 13°N, speed- 6.4knots, D=992m.

SVP cast and Begining of line (BOL)-17 at 1755gmt/10.09.08, 73°42'37"E; 13°N, speed- 5.8knots, D=930m.

11.09.2008: POSN at 0800hrs- 11°58.70'N; 73°42.50'E, SST- 28°C, Atm. Pr.- 1011.5mb, Depth- 2083m, Ship Speed- 7.3 kts, sky overcast, seastate 4-5.

End of Line (EOL)-17 at 1235gmt/11.09.08, 73°42'35"E; 11°N, speed- 8.1knots, D=1967m.

SB3012 hanged/failed to ping at around 0345gmt/11.09.08, restarted HSO/TX/RX and re-occupied the survey track.

SVP cast and Begining of line (BOL)-18 at 1500gmt/11.09.08, 73°45'20"E; 11°N, speed- 4.5knots, D=2053m.

12.09.2008: POSN at 0800hrs- 12°03.31'N; 73°45.25'E, SST- 27.5°C, Atm. Pr.- 1011.5mb, Depth- 2008m, Ship Speed- 5.1kts, sky overcast, seastate 4-5.

End of Line (EOL)-18 at 1305gmt/12.09.08, 73°45'17"E; 13°N, speed- 6.3knots, D=823m.

Begining of line (BOL)-19 at 1351gmt/12.09.08, 73°48'E; 13°N, speed- 6.0knots, D=656.7m.

13.09.2008: POSN at 0800hrs- 11°38.61'N; 73°48'E, SST- 27.5°C, Atm. Pr.- 1010.5mb, Depth- 2046m, Ship Speed- 6.4kts, sky overcast, seastate 4.

End of Line (EOL)-19 at 0648gmt/13.09.08, 73°48'E; 11°N, speed- 6.9knots, D=2166m.

Gravity Corer operated at 1400hrs LT/13.09.08, POSN- 73°59.45'E; 10°58.08'N, Depth- 2161m, Recovery- 4.2m.

Power blackout at 1930 hrs LT /13.09.08, SB3012 restarted. System did not ping on first startup required proper shutdown then started normally. DTM not painting.

SVP cast and Beginning of line (BOL)-20 at 1520gmt/13.09.08, 73°50'42"E; 11°N, speed- 6.0knots, D=2253m.

14.09.2008: POSN at 0800hrs- 12°19.50'N; 73°50.65'E, SST- 27.5°C, Atm. Pr.- 1013.5mb, Depth- 1506m, Ship Speed- 6.9kts, sky overcast, seastate 4.

End of Line (EOL)-20 at 0900gmt/14.09.08, 73°50.42'E; 13°N, speed- 7.8knots, D=194.5m.

Gravity Corer operated (GC-04) at 1540hrs LT/14.09.08, POSN- 73°59.46'E; 13°N, Depth- 124.4m, Recovery- 0.38m.

Beginning of line (BOL)-21 at 1155gmt/14.09.08, 73°53'24"E; 13°N, speed- 5.6knots, D=211m.

15.09.2008: POSN at 0800hrs- 11°16.14'N; 73°53.44'E, SST- 28°C, Atm. Pr.- 1013.5mb, Depth- 2061m, Ship Speed- 7.3kts, scattered clouds, seastate 3.

End of Line (EOL)-21 at 0437gmt/15.09.08, 73°53'24"E; 11°N, speed- 4.5knots, D=2247m.

SVP cast and Beginning of line (BOL)-22 at 0646gmt/15.09.08, 73°56'05"E; 11°N, speed- 6.9knots, D=2203m.

End of Line (EOL)-22 at 2240gmt/15.09.08, 73°56'06"E; 13°N, speed- 7.6knots, D=153.6m.

Beginning of line (BOL)-23 at 2318gmt/15.09.08, 73°58'48"E; 13°N, speed- 7.2knots, D=125.8m.

16.09.2008: POSN at 0800hrs- 12°35.10'N; 73°58.83'E, SST- 27.5°C, Atm. Pr.- 1013.5mb, Depth- 1184m, Ship Speed- 7.4kts, scattered clouds, seastate 3-4.

End of Line (EOL)-23 at 1456gmt/16.09.08, 73°58'48"E; 11°N, speed- 6.1knots, D=2161m.

SVP cast and Beginning of line (BOL)-24 at 1656gmt/16.09.08, 74°01'30"E; 11°N, speed- 6.0knots, D=2143m.

17.09.2008: POSN at 0800hrs- 12°07.21'N; 74°01.46'E, SST- 28°C, Atm. Pr.- 1013.5mb, Depth- 1388m, Ship Speed- 7.6kts, scattered clouds, seastate 3-4.

End of Line (EOL)-24 at 0800gmt/17.09.08, 74°01'30"E; 12°48'N, speed- 7.0knots, D=509m.

Patch-up survey in shallow water areas of survey block, completed at 2215hrs LT/17.09.08.

Magnetometer deck trials were carried out successfully during MB patch surveys. For sea trials, when the sensor was disconnected to pass the cable to Derek pulley and reconnected, the MagLog software did not connect to the sensor and flashed message stating 'Failed to open Sensor Mag'. After several trials the software was restarted and then the software Flashed message stating 'Your temporary MagLog License has been expired'. Operation aborted.

18.09.2008: POSN at 0800hrs- 13°46'N; 73°38.03'E, SST- 27.5°C, Atm. Pr.- 1013.5mb, Depth- 85m, Ship Speed- 5.6kts, seastate 3.

Underway data collection continued. Sailing to Mormugao Port.

19.09.2008: Vessel arrived and berthed at Mormugao port at 1520hrs. Scientific team disembarked from the vessel.

SK-249 Cruise completed successfully.

12. GENERAL OBSERVATIONS/ COMMENTS

SB-3012 related issues

1. Hydrostar software stopped data acquisition abruptly several times during survey. The software/trans-receiver required to be re-started for resuming data acquisition.
2. The HSO does not record or fails to record a single ping on change of file and sometimes drops several subsequent pings under normal survey conditions.
3. HSO display very frequently went blank and displayed the message "No signal input" for a few seconds.
4. Although the system manuals explain the general information about SB3012 operations, the system specific details are not documented, such as the basic settings of different software, interfacing, IP addresses etc., required in case of troubleshooting/ re-installation etc to save precious sea time.
5. No manual or documents for the WCI system are available. Help menu on the HS-WCI Program is also not available.
6. Job planner software hung on one occasion and worked very slow since then making data editing very difficult. A single XSE data file (approx. 10MB) took about 10-15min to open in the bottom window (plan view) after the incident. If several files (4 or 5 files) are selected together, then system starts reading data, pauses while reading Roll or Gyro data and stops, with the timeout message flashing after some time. On clicking the OK button on timeout pop-up, another pop-up flashes stating communication link failure and the process stops.

JobPlanner closes if Refresh button is pressed on empty Planview window.

7. Side Scan Imagery depth reference stamp: The annotation interval for online printer automatically shifts to default 1 minute interval.
8. Helmsman DTM painting fails/stops at times during surveys. Helmsman display DTM exit / retrieval facility requires to be incorporated. On one occasion the Helmsman display (ONLY) froze and had to be re-started.
9. EIVA Navipac System: All NaviPac modules Software hung/crashed quite often. Plot colour palette found not showing correct colour intervals. More nos. of colour palettes to be incorporated as only 3 palettes with max. 16 levels are available. Colour palette composer and import from other formats to be incorporated. Colour palette levels mismatch in NaviContour & NaviPlot on map composition. NaviModel fails to create list of files from different folders for loading to create a new model and crashes.
10. The Electronic Navigation Chart (ENC) as well as the Center beam Depth are not displayed on both the Helmsman displays, these are critical requirements for the navigators.
11. Naviplot crashes on opening 'Template files'. Facility to export composed maps in NaviPlot to misc. Image formats e.g. GeoTif, bmp, jpg etc. User defined 'Fixed' grid spacing option in s/w causes crash.
12. Softcopies of all manuals, "Level Converter Board" and hard disk for post-processing system to be provided by OEM.
13. Facility to export XYZ data with position data in Lat / Long format is awaited.
14. The only DVD-writer available in the SB3012 complex is non-operational, only CD-writers operational.

15. Hydrostar WCI program closes on clicking ‘Expand’(+) button for the ‘Connections’ link in the browser window.
16. Jobplanner (NaviEdit) program closes on clicking ‘Refresh’ button on a blank Planview.
17. NaviModel program not able to print the shaded model (prints a blank sheet with border and text. Grid settings on the printout are default even if the grid settings are changed and saved.
18. NaviPac and Hydrostar software installation CD’s not available onboard.

13. RECOMMENDATIONS

1. All SB3012 Multibeam system problems should be rectified at the earliest opportunity, best before the next Multibeam survey cruise.
2. Post processing system is very slow in handling the data. System RAM can be upgraded.
3. The Electronic Navigational Charts (ENC) can be upgraded by downloading over internet, if possible.
4. A need for printing the Sidescan images with a PDF printer is felt so that the images are stored for future references, as the thermal printer paper may not be kept for long.
5. The s/w for processing the Side Scan and Backscatter data in not available onboard, a requirement.

14. ACKNOWLEDGEMENT

The Chief Scientist and participants of Cruise SK-249 place on record their deep sense of gratitude to Director, National Centre for Antarctic and Ocean Research, Goa for assigning responsibilities for carrying out swath bathymetric surveys off-Lakshadweep Islands.

Team is also thankful to Dr. M. Sudhakar, Group Director (OSSG), NCAOR for able guidance, constant motivation and support for the success of the cruise. Mr. M.M. Subramaniam (SK-Cell), NCAOR is thanked for all the timely support, communication from ship and cruise arrangements.

The technical support and co-operation rendered by NORINCO is appreciated.

The Scientific team also wishes to thank the Master and crew of the vessel for their supreme co-operation during the cruise and excellent navigation.

Date: 19th Sept 2008
Place: Onboard ORV Sagar Kanya

(ABHISHEK TYAGI)
Chief Scientist (SK-249 cruise)

Annexure-I Way points of the Survey Lines

01.	13° N	73° 00.0′ E
02.	11° N	73° 00.0′ E
03.	11° N	73° 02.5′ E
04.	13° N	73° 02.5′ E
05.	13° N	73° 05.0′ E
06.	11° N	73° 05.0′ E
07.	11° N	73° 07.5′ E
08.	13° N	73° 07.5′ E
09.	13° N	73° 10.2′ E
10.	11° N	73° 10.2′ E
11.	11° N	73° 12.9′ E
12.	13° N	73° 12.9′ E
13.	13° N	73° 15.6′ E
14.	11° N	73° 15.6′ E
15.	11° N	73° 18.3′ E
16.	13° N	73° 18.3′ E
17.	13° N	73° 21.0′ E
18.	11° N	73° 21.0′ E
19.	11° N	73° 23.7′ E
20.	13° N	73° 23.7′ E
21.	13° N	73° 26.4′ E
22.	11° N	73° 26.4′ E
23.	11° N	73° 29.1′ E
24.	13° N	73° 29.1′ E
25.	13° N	73° 31.8′ E
26.	11° N	73° 31.8′ E
27.	11° N	73° 34.5′ E
28.	13° N	73° 34.5′ E
29.	13° N	73° 37.2′ E
30.	11° N	73° 37.2′ E
31.	11° N	73° 39.9′ E
32.	13° N	73° 39.9′ E
33.	13° N	73° 42.6′ E
34.	11° N	73° 42.6′ E
35.	11° N	73° 45.3′ E
36.	13° N	73° 45.3′ E
37.	13° N	73° 48.0′ E
38.	11° N	73° 48.0′ E
39.	11° N	73° 50.7′ E
40.	13° N	73° 50.7′ E
41.	13° N	73° 53.4′ E
42.	11° N	73° 53.4′ E
43.	11° N	73° 56.1′ E
44.	13° N	73° 56.1′ E
45.	13° N	73° 58.8′ E
46.	11° N	73° 58.8′ E
47.	11° N	74° 01.5′ E
48.	13° N	74° 01.5′ E

Annexure-II Multi Beam Survey Record (SK-249)

Line No.	Date	BOL / EOL	Time GMT	Depth (m)	Latitude	Longitude	File No.
01	29.08.08	BOL	1340	1900	13° N	73° E	
	30.08.08	EOL	0335	1870	11° N	73° E	
02	30.08.08	BOL	0724	1852	11° N	73°02.30' E	
	30.08.08	EOL	2207	1927	13° N	73°02.27' E	
03	31.08.08	BOL	0015	1940	13° N	73°04.56' E	
	31.08.08	EOL	1400	1899	11° N	73°05' E	
04	31.08.08	BOL	1610	1923	11° N	73°07.29' E	
	01.09.08	EOL	0550	1938	13° N	73°07.29' E	
05	01.09.08	BOL	0954	1938	13° N	73°10'16" E	
	01.09.08	EOL	2330	1945	11° N	73°10'11" E	
06	02.09.08	BOL	0130	1950	11° N	73°12'21" E	
	02.09.08	EOL	1505	1937	13° N	73°12'52" E	
07	02.09.08	BOL	1712	1928	13° N	73°15'42" E	
	03.09.08	EOL	0646	1977	11° N	73°15'36" E	
08	03.09.08	BOL	1100	1962	11° N	73°18'18" E	
	04.09.08	EOL	0017	1880	13° N	73°18'18" E	
09	04.09.08	BOL	0222	1823	13° N	73°21' E	
	04.09.08	EOL	1812	1932	11° N	73°20'59" E	
10	04.09.08	BOL	2000	1930	11° N	73°22'29" E	
	05.09.08	EOL	1000	1721	13° N	73°23'41" E	
11	05.09.08	BOL	1206	1676	13° N	73°26'24" E	
	06.09.08	EOL	0138	1929	11° N	73°26'23" E	
12	06.09.08	BOL	0750	1676	13° N	73°26'24" E	
	07.09.08	EOL	1400	1024	13° N	73°29'06" E	
13	07.09.08	BOL	1524	293	13° N	73°31'48" E	
	08.09.08	EOL	0720	1916	11° N	73°31'41" E	
14	08.09.08	BOL	0800	1894	11° N	73°33'28" E	
	09.09.08	EOL	0150	1046	13° N	73°34'29" E	
15	09.09.08	BOL	0345	1051	13° N	73°37.19' E	
	09.09.08	EOL	2012	1922	11° N	73°37'11" E	
16	09.09.08	BOL	2100	1934	11° N	73°39'55" E	
	10.09.08	EOL	1630	992	13° N	73°39'52" E	
17	10.09.08	BOL	1755	930	13° N	73°42'37" E	
	11.09.08	EOL	1235	1967	11° N	73°42'35" E	
18	11.09.08	BOL	1500	2053	11° N	73°45'20" E	
	12.09.08	EOL	1305	823	13°N	73°45'17"E	
19	12.09.08	BOL	1351	656.7	13°N	73°48'E	
	13.09.08	EOL	0648	2166	11°N	73°48'E	
20	13.09.08	BOL	1520	2253	11°N	73°50'42"E	
	14.09.08	EOL	0900	194.5	13°N	73°50.42'E	
21	14.09.08	BOL	1155	211	13°N	73°53'24"E	
	15.09.08	EOL	0437	2247	11°N	73°53'24"E	
22	15.09.08	BOL	0646	2203	11°N	73°56'05"E	
	15.09.08	EOL	2240	153.6	13°N	73°56'06"E	
23	15.09.08	BOL	2318	125.8	13°N	73°58'48"E	

	16.09.08	EOL	1456	2161	11°N	73°58'48"E	
24	16.09.08	BOL	1656	2143	11°N	74°01'30"E	
	17.09.08	EOL	0800	509	12°48'N	74°01'30"E	

Annexure-III Details of operations for SDM College of Engg. & Tech., Dharwad

The Gravity corer was operated at:

Station	Id no.	Longitude and Latitude	Recovery Length (m)
1	SDM/GC-1	73^0 55.13'E & 14^0 25.35' N	0.5
2	SDM/GC-2	74^0 22.8'E & 13^0 52.42'N	2.89
3	SDM/GC-3	74^0 7.96'E & 13^0 40'N	4.82

CTD with water samplers and Grab was operated at:

Station	Longitude and Latitude	Sample Type	Water sampled depth (m)
1	74^0 26.51'E & 13^0 51.95 N	Water & Grab sample	20 & 4
2	74^0 09.91'E & 13^0 44.97' N	Grab sample	———
3	74^0 24.56'E & 13^0 52.43' N	Grab sample	———
4	74^0 25.61'E & 13^0 52.14' N	Water & Grab sample	20 & 6
5	74^0 27.40'E & 13^0 52.50' N	Grab sample	———
6	74^0 28.36'E & 13^0 52.58' N	Water & Grab sample	17 & 3
7	74^0 29.02'E & 13^0 52.47' N	Grab sample	———
8	$74^0$10.00'E & 13^0 51.50' N	Water & Grab sample	40 & 6
9	74^0 23.69'E & 13^0 51.61' N	Grab sample	———
10	74^0 23.79'E & 13^0 49.41' N	Water & Grab sample	28 & 6
11	74^0 23.81'E & 13^0 47.06' N	Grab sample	———
12	74^0 23.81'E & 13^0 46.01' N	Water & Grab sample	27 & 6
13	74^0 26.63 E & 13^0 46.83' N	Grab sample	———
14	74^0 26.28'E & 13^0 49.24' N	Water & Grab sample	22 & 4
15	74^0 26.49'E & 13^0 50.80' N	Grab sample	———
16	74^0 27.75'E & 13^0 51.50' N	Water & Grab sample	18 & 3
17	74^0 28.19'E & 13^0 49.60' N	Grab sample	———
18	74^0 28.95'E & 13^0 46.64' N	Water & Grab sample	18 & 5
19	74^0 29.01'E & 13^0 45.08' N	Grab sample	———
20	74^0 10.00'E & 13^0 40.06' N	Water & Grab sample	40 & 4

Annexure-IV Details of Operations under EEZ programme

STN. NO.	DATE	LATITUDE	LONGITUDE	DEPTH (m)	STATION TIME	SST (ºC)	EQUIPMENT OPERATED
1	29/08/08	13º40.00' N	74º07.96' E	48	06:50	27.5	GRAVITY CORE (GC-01)
2	29/08/08	12º59.29' N	73º00.18' E	1896	18:20	27.5	SVP
3	30/08/08	11º02.10' N	72º59.40' E	1875	09:30	27	GRAVITY CORE (GC-02), SVP
4	31/08/08	13º00.02' N	73º02.27' E	1927	03:58	28	SVP
5	31/08/08	10º59.73' N	73º04.75' E	1971	19:50	27.5	SVP
6	01/09/08	13º00.29' N	73º07.67' E	1933	11:15	28.5	SVP, CTD
7	02/09/08	10º59.73' N	73º09.88' E	1936	05:15	27	SVP
8	02/09/08	13º00.84' N	73º12.74' E	1931	20:55	28	SVP
9	03/09/08	10º58.23' N	73º18.47' E	1944	15:00	28.5	SVP
10	04/09/08	13º00.73' N	73º18.04' E	1880	06:00	28	SVP
11	05/09/08	13º01.29' N	73º24.24' E	1718	16:05	28.5	SVP
12	06/09/08	10º59.77' N	73º26.11' E	1932	07:15	28	SVP
13	07/09/08	13º00.51' N	73º28.75' E	1213	20:14	28	SVP
14	09/09/08	13º01.22' N	73º34.51' E	1046	07:50	28	SVP
15	10/09/08	13º00.36' N	73º40.34' E	968	22:00	28	SVP
16	11/09/08	13º59.08' N	73º44.67' E	1958	25:25	28	SVP
17	13/09/08	10º58.08' N	73º59.45' E	2061	14:00	28	GRAVITY CORE (GC-01)
18	13/09/08	10º58.52' N	73º50.60' E	2040	18:35	28	SVP
19	14/09/08	13º00.25' N	73º59.46' E	124.4	15:38	28	GRAVITY CORE(GC-01)
20	15/09/08	10º59.65' N	73º53.30' E	2248	10:25	28	SVP
21	17/09/08	10º59.34' N	73º58.78' E	2169	20:45	28	SVP
22	17/09/08	13º04.67' N	73º44.12' E	652	23:00	28	MAGNETOMETER Trials

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