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Cruise Report
ORV SAGAR KANYA
EXCLUSIVE ECONOMIC ZONE OF INDIA

Ratan Srivastava,
Chief Scientist, Cruise No. SK-310
(10th March 2014-19th March2014)

National Centre for Antarctic & Ocean Research
Ministry of Earth Sciences, Government of India
Headland Sada, Vasco-Da-Gama, Goa – 403804, India

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1. **Introduction:** The Exclusive Economic Zone (EEZ), about 200 nautical miles from coast, the zone outside the territorial water of the country over which a country is permitted to do economic activities like fishing and is entitled to use the natural resources of the area. The detail map of the EEZ is useful in the following purposes:
   - (i) The Navy and Coast Guards for strategic purposes,
   - (ii) Fishermen for fishing operations using deep trawl or bottom fishing gear,
   - (iii) Petroleum, natural gas and mineral exploration as well as exploitation,
   - (iv) Development and assessment of mineral resources,
   - (v) Telecommunication industry for lying cables,
   - (vi) Sub-sea pipe lines for geological hazard assessment,
   - (vii) Effective disposal of waste and reducing pollutants,
   - (viii) Ocean engineers for constructing and maintaining structures of port and harbor.

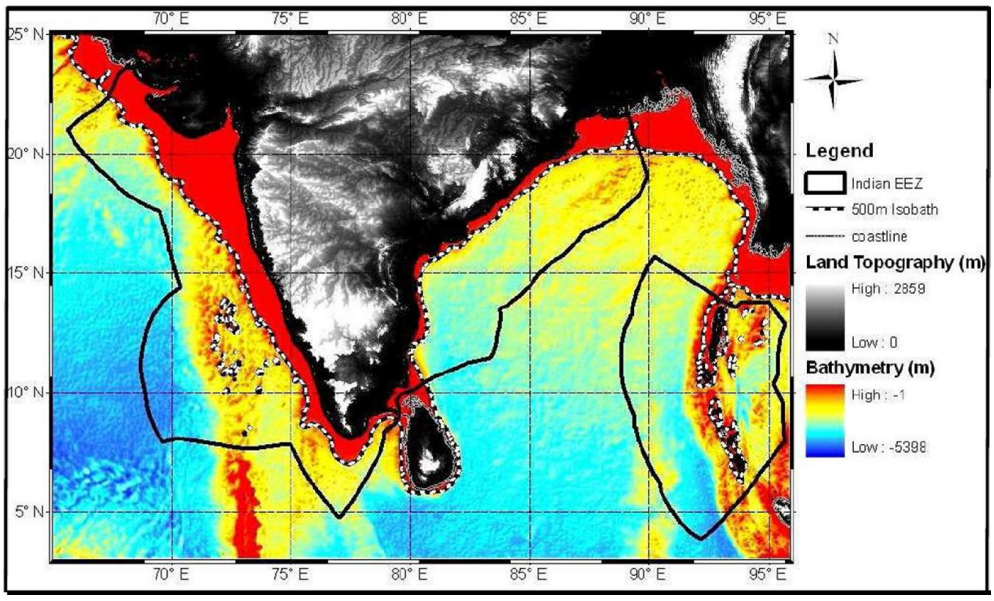

Figure 1: Map Shows Exclusive Economic Zone of India

2. **Objectives:** The objective of this cruise was to survey the East coast region of Chennai using the SeaBat 7150 Multibeam Echo-Sounder (MBES) onboard ORV Sagar Kanya and prepare a comprehensive bathymetry map of Off Chennai region . The scientific personnel boarded in the ship on 10th March 2014 at Chennai Port, Tamil Nadu and started sailing on 11th March 2014 towards the designated survey area.

3. **Cruise Itinerary:**

Boarding	: Chennai Port, Tamil Nadu on 10th March , 2014
Departure	: Chennai Port, Tamil Nadu on 11th March 2014
Arrival	: Chennai Port, Tamil Nadu on 19th March 2014
Total no of days	: 09 days

4. List of Participants: Participants in ORV Sagar Kanya Cruise SK-310 are as follows:

National Centre for Antarctic & Ocean Research, Goa

1.	Ratan Srivastava	Chief Scientist
2.	Mr. Jaggu Naidu	Research Scientist 'B'
3.	Mr. Suman Kilaru	Research Scientist 'B'
4.	Mr. Goverdhan Kantepudi	Scientific Assist.
5.	Mr. Paresh Pole	Shipboard Assistant

M/s Norinco Pvt. Ltd.

18.	Mr. V.C Saratchandran	AMC-Service Engineer
19.	Mr. Avertano Callistus Luis	AMC-Service Engineer
20.	Mr. G.K Tharanithran	AMC-Service Engineer
21.	Mr. Manikandan Srinivas Moorthy	AMC-Service Engineer
22.	Mr. Ranganathan Vinothkumar	AMC-Service Engineer

5. Area of Operation: The survey was carried out to developed bathymetry map of seabed in Indian EEZ. The proposed area is of EEZ located near Chennai in East Coast of India. The present mapping comprises of 07 MBES survey lines (~1770 lkms.) with 8.5 km to 7.5 kms spacing between two consecutive lines and one patch line is covered.

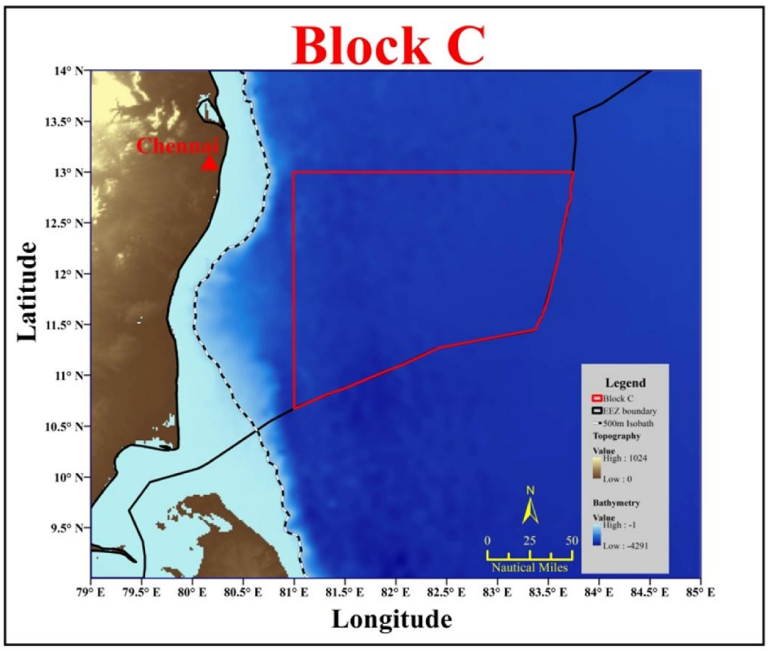

Figure 2: Survey Area (Block C) near Chennai in BOB .

Total length of cruise track during the survey is ~1770 line kms. There are 04 CTD profile stations and 2 gravity core station were done. Total area~11,730 km^2 covered during the cruise SK-310. The designated area of MBES survey has given in Figure 2.

6. **Planning of Survey Lines:** The present ORV Sagar Kanya Cruise SK-310 is plan to carry MBES and Magnetic survey in Block-C near Chennai, India. One Patch Survey PL Line is also planned in the latter part of the mapping to cover the data gaps. There are 04 CTD stations planned for sound velocity correction of data set. The detail planned cruise track lines and CTD stations are shown in Fig 3.

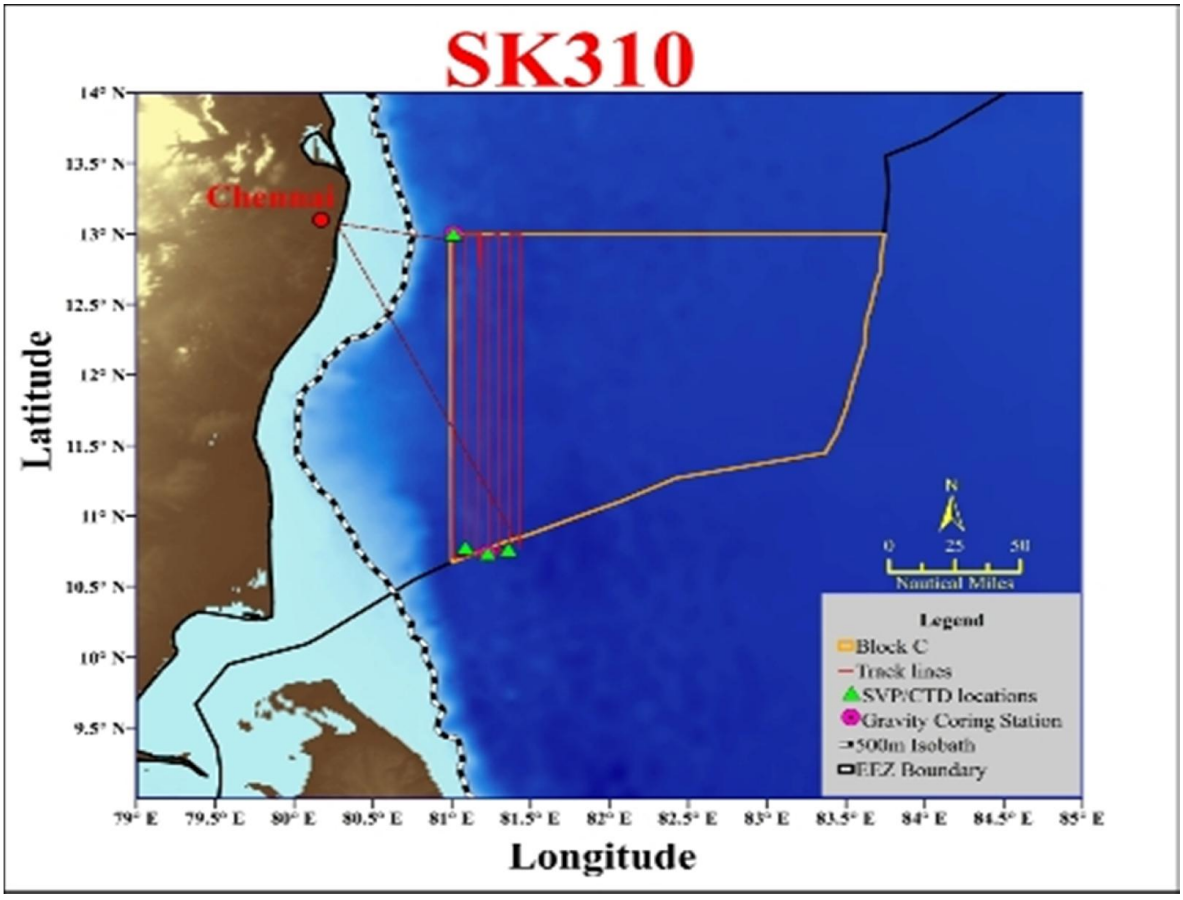

Figure 3: Detail MBES Survey area during Cruise SK-310 in Block C

7. Technical Specifications of Equipments:

7.1. Multi-Beam Echo-Sounder System: The MBES survey was carried out using standard practice with reference to the methodology described in the special publication no 44 (S-44), International Hydrographic Organisation (IHO), Standards for Hydrographic Surveys,5th Edition (2008). SeaBeam 3012 Multibeam Echo-Sounder onboard ORV Sagar Kanya was used to carry out the MBES survey near Chennai in Bay of Bengal. The SB3012 is a 12 kHz, 201 beam sonar system, has a beam width of 1° at nadir and is capable of measuring depths ranging from 200 m to 11000 m. The technical specification of the SB-3012 MBES system is as follows:

Manufacturer	: L3-Communications ElAC-Nautik GmbH, Germany
Power Supply	: 115/230V AC (user selectable)
Number of Beams	: 201
Swath Coverage	: 140° SeaBeam 3012, 2° × 2° (5.5 × Depth), ~20 dB backscatter Depth = 4000 to 11, 000 m Coverage = 22,000 to 31,400 m
Frequency of Operation	: 12 kHz
Max. Source Level	: 1° = 247 dB/mPa 2° = 241 DB/mPa
Pulse Length	: 2, 3, 5, 7, 10, 14, 20 ms
Beam Width	: 1° or 2°
Side Lobe Suppression	: > -30 dB
Survey Speed/Swath Width	: 1° beam, 120° swath or 2°, 140° at 12 kn 2° beam, 120° swath at 24 kn
Technology	: Full motion compensation (Sweptbeam technology)
Acquisition Software	: Hydrostar
Data Processing Software	: Caris

The complete Multibeam system comprises of many sub systems:

Surface Sound velocity (SSV): The surface sound velocity profiler is an underway ocean surface profiling system that can collect the water sound speed continuously.

Side Scan Imagery: Online printer provided with system and annotation interval was set at 30 minutes for acquiring side scan imagery.

Gyro & Motion Sensor: Multibeam system uses Octans sensor for Gyro and motion input. Octans is an IMO compliant survey grade gyrocompass with an integral motion sensor.

Positioning System: The 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 uer 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 Time Server 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 timeserver can also be configured and monitored remotely from a work station via TEL/NET 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-server 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 by up to three valued time sources. NTP enable the comparison of the hardware times and the adjustment of the own clock, a time precision of 128 ms, often better than 50 ms is possible.

7.2. Sound Velocity Profile: The sound velocity profilers have a velocimeter that operate on the "sing-around" sound principle, and contain a transducer head and a reflective plate a known distance apart. The "sing-around" sound principle refers to the use of a transducer and reflective-plate pair that is known distance apart. The device calculates the speed of sound in water by effectively dividing this known distance by one-half the time required for a signal to be transmitted by the transducer, reflected by the reflective plate and received by the transducer. The sound velocity profiler used onboard ORV Sagar Kanya was Valeport MIDAS SVX2. The onboard processor calculates the sound velocity every second and stores it in the inbuilt memory of the SVP. The SVP data is uploaded after retrieval using the onboard data logging software. The MIDAS SVP is one of the most accurate sound velocity profiler in the world. It used digital time of flight sound velocity sensor. It also comes with a pressure sensor with 0.01 % accuracy, a fast response PRT sensor and a high accuracy temperature compensated piezo-resistive pressure sensor. The SVP instrument was attached with CTD under-water unit to collect the sound velocity profiles at 4 stations near Chennai coast in Bay of Bengal with depths ranging from 1500 m to 2500 m.

Technical Specification for Sound Velocity:

Range : 1400 to 1600 m/s (extended range on request)
Resolution : 0.001 m/s
Accuracy : ±0.03 m/s

Mechanical Specifications & Materials

Housing : Steel; Exceptions : Sound velocity sensor uses carbon composite rods
Cage: Stainless steel (316 grade) with polypropylene clamping brackets
Dimensions: Instrument 88 mm Ø, 540 mm long (including connector)
Weight (in cage): 7.5 kg (air), 4.5 kg (water)
Depth Rating: 500 m (unless smaller pressure sensor fitted)

Connectors:

Instrument: 10 pin female Subconn bulkhead type (MCBH10F) with lock ring.
Comms Cable: Valeport 3 m Y lead. 10 pin male subconn line type (MCIL10M) to instrument, 2 × 4 mm bunch pins to external power, 9 pin female D type to PC.
Switching Plug: 10 pin male Subconn line type (MCIL10M) with lock ring.

Performance:

Memory: 16 Mb solid state memories (upgradeable in 16 Mb steps to 64 Mb)
Internal Power: 8 × 1.5 volt alkaline C cells. The unit will accept 8 × 3.6 volt Li C cells with no alteration required. Do not mix battery types.
External Power: between 9 and 30 volt DC
Current Drain: ~50 mA at 12 volt when running, and 0.25 mA in sleep mode
Sampling Rate: 1, 2, 4 or 8 Hz (synchronized)
Data Output: RS232, RS485 or RS422 depending on pin selection. Baud rate is user selectable from 2400 to 460800

Sampling Mode:
Profile Mode: This mode sets the instrument to take readings at fixed depth intervals as it is lowered and raised through the water column
Electrical Specifications
Internal: 8 × C cells, 1.5 V alkaline or 3.6 V lithium battery; External: 9 to 30 V DC
Power: 0.7 W (sampling and <1 mW (sleeping)
Battery Life: <100 hours operation (alkaline) & <250 hours operation (Li)
Connector: Subconn titanium MCVH10F
Communications: The instrument will operate autonomously with setup and data extraction performed by direct communications with PC before and after deployment. It also operates in real time with a choice of communication protocols for a variety of cable lengths, all fitted as standard and selected by pin choice on the output connector.
Standard:
RS232: up to 200 m cable, direct to serial port via USB adaptor
RS485: up to 1000 m cable addressable half duplex communications
Memory: The MIDAS sVX2 fitted with 16 Mb solid-state non-volatile flash memories. Total capacity depends on sampling mode such as continues and burst modes have a single time stamp at the start of the file. Trip mode stores a time stamp with each reading. A single line of SVP data uses 10 bytes and a time stamp uses 7 bytes.
Continues: > 16,00,000 data points; Profile: > 9,80,000
Data Accusation: The MIDAS SVX2 uses the concept of distributed processing, where each sensor has its own microprocessor controlling sampling and calibration or readings. Each of these is then controlled by a central processor, which issues global commands and handles all the data. This means that all data is sampled at precisely the same instant giving superior quality profile data.
Software: System is supplied with DataLog Express Windows based PC software for instrument setup, data extraction and display. DataLog Express is license free.

7.3. Seafloor Sampling (Gravity Coring): Gravity corer is an instrument in which a weight is freely dropped down to the seabed. At the foot corer has steel chisel point with core flap so called spider. There are metal ballast weight rings and cap block with water valve on the top side of the corer. There is polyethylene pipe inside steel corer for reducing core friction and convenience of sampling. Gravity corer is lifting down using winch with the speed of about 1-1.5 m/s until the drop point (~70-100 meters above the seabed) and then it is dropping with the speed of about 3-4 m/s for providing a maximum speed of penetration inside the bottom. After penetration it is immediately winching up to avoid corer hogging while vessel drifting.

Technical Specifications

Material: Steel;	Length : 6 meters;	Inner Diameter : 150 mm;
Outer Diameter	: 168 mm;	Weight : 1000 kg;
Lifting Speed	: 1 to 1.5 m/s;	Drop Speed : 3 to 4 m/s

8. Method of Data Collection & Analysis: Hydrostar is the data acquisition and control system for Multibeam echosounder onboard ORV Sagar Kanya. It also acts as an interface for various external sensors (position, motion, heading and sound velocity sensors). Caris software was used for data processing from various feeds such as GPS, Gyro, Motion sensor, etc. The 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. Caris is the software used to edit the data and create the bathymetric grid model. The processed multibeam datasets of Block-C were imported, mapped, and analyzed in the same platform. During the Cruise SK-310 following data were acquired

Multi Beam Echo-Sounder Bathymetry :1770 line kms.
CTD Stations : 4 no

9. Diary of Events: The ORV Sagar Kanya Cruise SK-310 sailed from Chennai Port on 11th March 2014 by 20:00 hrs (IST) towards designated survey area about 41 miles away from Chennai. On 12th March 2014, the vessel arrived in the planned survey area and started bathymetry survey. The bathymetry survey is continued until 19th March 2014. Four CTD operation was conducted during this period. On 18th March 2014 at 15:00 hrs (IST), vessel transited from survey area towards Chennai and anchored on 19th March 2014 at 10:00 hrs (IST) near Chennai Port.

Abbreviations: IST = India Standard Time
UTC = Coordinated Universal Time i.e., GMT
Lat = Latitude
Long = Longitude

The detail sequences of events discuss as follows date wise:

9.1. Date 10/03/2014:

12:30 (IST): Sign-On in ORV Sagar Kanya for 08 participants.
18:00 (IST): All participants were boarded & materials loaded in vessel
17:00 (IST): Bunkering not done so delay in ETA.

9.2. Date 11/03/2014:

Ship sailed towards survey area at 20:00 hrs.
22:00(IST): MB system tested and the data acquisition software not working while heading towards survey area.

9.3. Date 12/03/2014:

Reached Survey at 04 00 hrs.Took one gravity core and CTD at the start of line.

21:30 (IST): Start of 1st MB line .
23:58 hrs(IST):Magnetometer lost in water.

9.4. Date 13/03/2014

00:04(IST): MBES data not displayed due to technical problem.Problem solved at 00:09 hrs. : MB data Stopped recording.
14:45 hrs : End of Line 1.
18:30 Hrs: 2nd CTD completed
18:35 Hrs: 2nd line started

9.5. Date 14/03/2014:

11:00 Hrs(IST): End of line 2
13:00 Hrs :Start of line 3
15:00 Hrs : Start of Line 3A

9.6. Date 15/03/2014:

09:00 Hrs : End of line 3A.
10:50 Hrs: Gravity Core 2.
15:30 Hrs:3rd CTD cast done and start of line 4.

9.7. Date 16/03/2014:

08:50 Hrs:Start of Line 5.

9.11. Date 17/03/2014:

*01:*30 Hrs: End of line 5.
*02:*30 Hrs: CTD Start
*05:*15 Hrs: CTD on Deck
*05:*30 Hrs: Start of line 6.
*21:*50 Hrs: End of line 6.
*22:*30 Hrs:Start of Line 7.

9.13. Date 18/03/2014:

15:00 Hrs: End of Line 7.
15:10 Hrs: Transit to patch line.
22:00 Hrs: End of transit line.
22:10 Hrs: Start of Patch line.
23:58 Hrs: End of patch line.

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9.14. Date 19/03/2014:

10:00 Hrs : Reached Chennai Port.

11. Appendix:

Annexure I: Tables Shows Coordinates of MBES Survey Lines in SK-310

Line No	**Starting Co-ordinates**		Depth	**Ending Co-ordinates**		Depth
	Long	**lat**		long	lat	
1	81.010903	12.95054667	3483	81.010903	10.7072742	3637
2	81.0882245	10.70838072	3618	81.087528	13.0018188	3480
3	81.17894117	13.007551	3456	81.1780987	12.7734008	3487
3A	81.16631267	12.99873017	3464	81.1599192	10.718665	3600
4	81.22974683	10.73712783	3611	81.2305075	12.9784837	3454
5	81.30023144	13.00023144	3463	81.3001485	10.7477013	3643
6	81.361976	10.76666667	3677	81.3666443	12.9952742	3478
7	81.43313117	13.00167433	3505	81.4330665	10.7766369	3710

Annexure II: Summary of CTD stations in SK-310

Date	Time(GMT)	Longitude	Latitude	Name	Depth	Remarks
12.03.14	02:30	81°00'41.3970	13°00	CTD-01	3380	Beg. of line 01
13.03.14	10:16	81°05'17.6082	10°46'30.1706"	CTD-02	3698	Beg. of line 02
15.03.14	08:50	81°13'47.0628	10°44'07.3998"	CTD-03	3611	Beg. of line 04
16.03.14	20:57	81°21'39.4146	10°45'41.6568"	CTD-04	3674	Beg. of Line 06.

Annexure III: Summary of Sediment coring stations in SK-310

Details on Sediment Coring							**Remarks**
Date	Time(GMT)	Longitude	Latitude	Name	Depth	Core length	
12.03.14	22:30	81°00'41.3970	13°00'	GC-01	3477	2.4M	Start of Line 1.
15.03.14	05:19	81°13'47.8242	10°44'05.5020	GC-02	3611	5.64M	Start of Line 4

Annexure IV: <u>Summary of MBES Data Details in SK-310:-</u>

Date	Time(GMT)	Longitude	Latitude	Depth (m)	Filename	Remarks
12.03.2014	16:02:04	81.010903	12.95054667	3483	line 01_201412Mar155328	**SOL_line_01**
13.03.2014	09:14:00	81.009893	10.7072742	3637	line 01_201413Mar084727	**EOL_01**
13.03.2014	13:01:34	81.0882245	10.70838072	3618	line02_201413Mar130 156	**SOL_02**
14.03.2014	05:51:02	81.087528	13.0018188	3480	line02_201414Mar053 152	**EOL_02**
14.03.2014	06:47:44	81.17894117	13.007551	3456	line03_201414mar064 749	**SOL_03**
14.03.2014	08:29:30	81.1780987	12.7734008	3487	line03_201414mar081 005	**EOL_03**
14.03.2014	09:57:00	81.16631267	12.99873017	3464	line03A_201414mar09 5736	**SOL_03A**
15.03.2014	03:30:00	81.1599192	10.718665	3600	line03A_201415Mar0 31506	**EOL_03A**
15.03.2014	09:55:00	81.22974683	10.73712783	3611	line04_201415Mar095 532	SOL _04
16.03.2014	02:30:00	81.2305075	12.9784837	3454	line04_201416Mar022 252	**EOL_04**
16.03.2014	03:18:11	81.30023144	13.00023144	3463	line 05_201416Mar031806	**SOL_05**
16.03.2014	20:00:00	81.3001485	10.7477013	3643	line05_201416Mar194 735	**EOL_05**
16.03.2014	23.59.01	81.361976	10.76666667	3677	line06_201416Mar235 902	**SOL_06**
17.03.2014	16:17:00	81.3666443	12.9952742	3478	line06_201417Mar160 245	**EOL_06**
17.03.2014	16:55:00	81.43313117	13.00167433	3505	line 07_201417Mar165537	**SOL_07**
18.03.2014	09:29:57	81.4330665	10.7766369	3710	Line 07_201418Mar092957	**EOL_07**

Annexure IV: Summary of MBES Survey Data in SK-310

The ORV Sagar Kanya Cruise SK-310 expedition results are located in the Hard Disk folder (SK310 Data) with the following structure:

SK310 Data	…/MBES Log File	…/SK310MBES Log.xls …/Cruise Report SK310.pdf
	…/Other Files	…SK310.hydrostar
	…/Processed Data	In organized format according to Caris
	…/Raw Data	In organized format as XSE and SSV
	…/SVP Files	…/CTD-01-SK310_ March 2014.sva …/CTD-02-SK310_ March 2014.sva …/CTD-03-SK310_ March 2014_.sva …/CTD-04-SK310_ March 2014.sva

12. Acknowledgements: I am duly acknowledged Dr. S. Rajan, Director and Dr. John Kurian, Scientist, National Centre for Antarctic & Ocean Research, for their generous support and encouragement in marine geoscientific investigations. I would like to thank Mr. M. M. Subramanian, NCAOR, and its Sagar Kanya Cell, who took special interest in our scientific requirements for this cruise and were supportive with respect to our appropriate logistic arrangements.

Captain , Master, navigational officers, and crewmembers are thankful for their extended and co-operative support during scientific operations in Cruise SK-310

. I am very grateful to Mr. Sarath and his NORINCO team members for their hard work and problem solving skills on scientific instrumentation and onboard operations, which made it possible to acquire large amount of geophysical datasets during this cruise. Finally, I would like to thank all scientific personals as participants of ORV Sagar Kanya Cruise SK-310 and their excellent support in making successful completion of this scientific expedition.

Date: 19 March, 2014
Place: Chennai Port, Goa, India

(Ratan Srivastava)
Chief Scientist
Research Scientist 'B', EEZ,
National Centre for Antarctic & Ocean Research
Headland Sada, Vasco-Da-Gama, Goa 403804,
India