

Marine Geophysical Surveys:

Geophysical methods involve the study of those parts of the earth hidden from direct view by measuring their physical properties with appropriate instruments, usually on or above the surface. It also includes interpretation of the measurements to obtain useful information on the structure and composition of the concealed zones.

Activities of Marine Geophysical Survey in the M&CSD, GSI is extensively involved in the application of Magnetic, Gravity and Seismic (Single channel & Multichannel) Survey methods in the Territorial Waters and within the EEZ of India. These Geophysical surveys were conducted across the strike of the existing Geological formations and structural trend in the EEZ of Andaman Sea, East and West Coast of India. The survey transect separation is about 5km and the tie line usually taken perpendicular to the transects. The repeatability of the measurements at the intersections of the tie-lines and the main lines provides a check on the reliability of the survey.

Activities carried out by Geophysical Division of M&CSD in GSI:

The Geophysical investigations were mostly focused on continental margins of India encompassing deep-water regions, mid-ocean ridges, aseismic ridges, subduction zones and Andaman Sea including the back-arc basin. The studies were aimed at unraveling the morphology of seafloor, delineation of sub surface geological features, major structural-tectonic and physical processes associated with evolution of the erosional-accretional, continental margins, ocean basins, volcanic structures, subduction zone etc.

Geophysicists of M&CSD has been engaged widely in industry related mapping for the mineral (Placer and Hydrothermal deposits) and energy resources such as gas hydrates mapping within the EEZ of India. The investigations were successfully carried out with integration of several geophysical datasets by acquiring new geophysical data on board research vessels of M&CSD of GSI. Major geophysical surveys carried out in M&CSD, GSI are Marine Magnetic, Gravity, Shallow Seismic Single channel and 2D multichannel Seismic.

Marine magnetic survey has been carried out both in the TW as well as in the EEZ of India. In Andaman sea within the EEZ magnetic survey has been carried onboard R.V. Samudra Manthan (Decommissioned) and R.V. Samudra Ratnakar. The objective of this survey is to understand the geological contacts, structural features and intrusive bodies and monitoring of changes (curie isotherm) around Narcondam and Barren Island.

Cesium Vapor marine magnetometer Model G-880 of Geometrics make, USA of 0.001 nT sensitivity is deployed for the magnetic survey with proper settings of tilt and rotation angle.

Marine Magnetic anomaly map prepared from the data collected on board R.V.Samudra Manthan in the Arabian Sea, Bay of Bengal and Andaman Sea within the EEZ of India has been compiled and available with good resolution map in the “Bhukosh” of GSI Portal for public use which can be very useful for inferring geophysical and geological regional and local basement depths, basins, structural and tectonic features within the prospect zone of Oil & gas basins in addition to the hydrothermal or intrusive mineralized zone.

Marine Gravimeter survey is carried out using Air-Sea Gravity system-II (Model S-168), Micro-G Lacoste Lafayette, Colorado, USA make installed onboard R.V. Samudra Ratnakar has been used for the survey since 2013. The operating range of Air-Sea Gravimeter is 12000

milli gals and 1 micro gal resolution. Till now gravity data has been acquired in all the 45 cruises carried out by GSI within the EEZ of India.

Shallow Seismic Survey has been carried out by M&CSD since 3 decades with the Analog and digital output. In East Coast of India, 69 shallow seismic cruises have been carried out till FSP-2018-2019. In the West Coast 64 shallow seismic cruises have been mounted till FSP-2018-2019. The Shallow seismic in the East coast has been covered almost 90% of the TW. Shallow seismic data processing and interpretation are carried out excellently and identified many important sub-surface features which are important for the engineering geology and mineral exploration. Features such as palaeo-channels, palaeo ridges, onlap and off lap features, progradational clinoform, lobes, sub-basins, stratigraphic contacts, humps, faults etc. it can be useful for the construction of dams, dredging of harbour channel and basin, development of ports, finding of submarine channels & other geotechnical investigations.

2D multichannel seismic survey has been carried out by M&CSD, GSI within the EEZ of India and Andaman Sea. The survey is taken up to study the Tectonic setting, delineation of the depositional horizon, morphological features along with the industrial investigation of Gas hydrates. Till now six cruises of 2D multichannel surveys have been carried out. Programs like DIGISHOT, DIGIBIRD, DIGISTREAMER, ORCA and BUOYLINK are used onboard. While carrying out 2D marine seismic survey, a 6 km long streamer cable having 480 channels is towed through the water at an average speed of about 4.5 knots. Three / four arrays of airguns with 5m separation and each array having 10 Nos. of air guns of 6000 cubic inch volume (2000 PSI) are fired at every 50m shot distance to map the subsurface geological features. During the seismic data acquisition process, GPS, DGPS and depth sensors provide positioning and depth of the streamer along seismic tracks respectively.

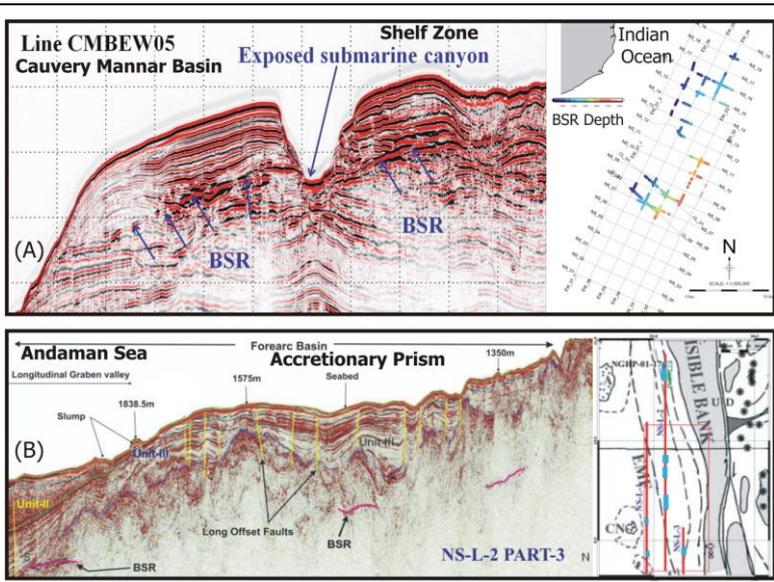
To generate geophysical and multi-disciplinary baseline data for gas hydrate studies two Gas hydrate investigation projects has been taken up by M&CSD, GSI in collaboration with NIO, Goa. SR-006 and SR-031 cruises are two gas hydrate cruises taken up to decipher stratigraphy and disposition of seabed, identification of BSRs related to gas hydrates occurrences in sub-seabed layers and basement geological features in Cauvery-Mannar, Indian Ocean and Zone of Accretionary prism at SW of Invisible Bank, Andaman Sea. The bottom simulating reflectors (BSRs), a proxy for the presence of gas hydrate, are observed in the central and north-eastern part of the SR-006 Cruise survey area, Cauvery Mannar Basin and presence of BSR at the SW of Invisible Bank in the SR-031 cruise area. At several locations, seismic signatures associated with free gas such as drop in interval velocity, pull-down structures, amplitude variation with offset (AVO), gas chimneys and attenuation are observed below the BSRs which confirms the presence of free gas in the study area.

The seismic survey in this zone of accretionary prism has clearly brought out the tectonic features such Fore arc high, Eastern Margin Fault (EMF), Forearc basin and Diligent Faults. 2D Multichannel Seismic Survey i.e., SR-019, SR-026 and SR-044 has been carried in the Zone of Subduction complex by M&CSD, GSI to identify the seismo-stratigraphy and structural pattern in Trench, 90°E Ridge and Accretionary Prism. The horst/graben features in the central part are results of normal faults due to extensional forces developed by the flexure bulging of the subducting Indo-Australian plate. Three types of sediments are identified along all the seismic sections in the study area, the highly reflective top of the basalt is capped by a thin layer of pelagic sediment overlain by the fan sediments and subsequently by the pre-wedge sediments.

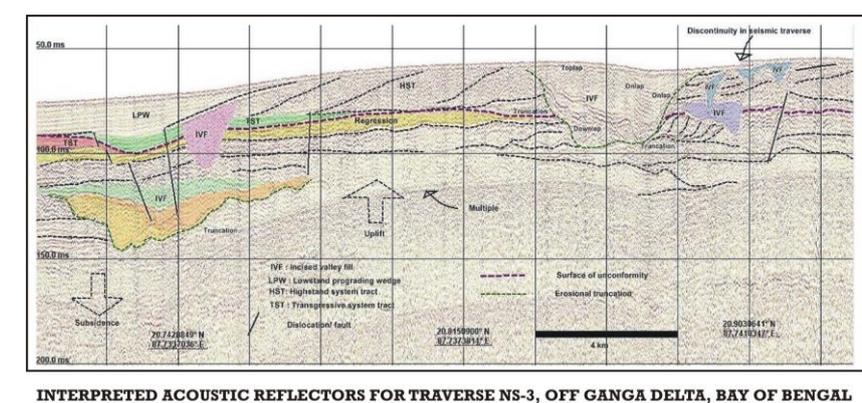
Most of the marine geophysical data within the EEZ of East and West coast of India and Andaman sea has been uploaded in the public domain in GSI web page Bhukosh (<http://bhukosh.gsi.gov.in/Bhukosh/Public>). Geophysicists of M&CSD have been trained in a few industrial establishments and universities abroad and in India for data acquisition, processing and interpretation. Main objective of the shallow seismic survey in the GSI along the East and Coast of the India has been for important input in understanding the coastal stratigraphic units as well as the depositional environment.

Some of the selected plates are given with sub headings for Photo purpose:

The bottom simulating reflectors (BSRs), a proxy for the presence of gas hydrate, are observed in a) central and north-eastern part of the SR-006 Cruise in Cauvery Mannar Basin and b) SW of Invisible Bank, Accretionary prism of SR-031 Cruise, Andaman sea.

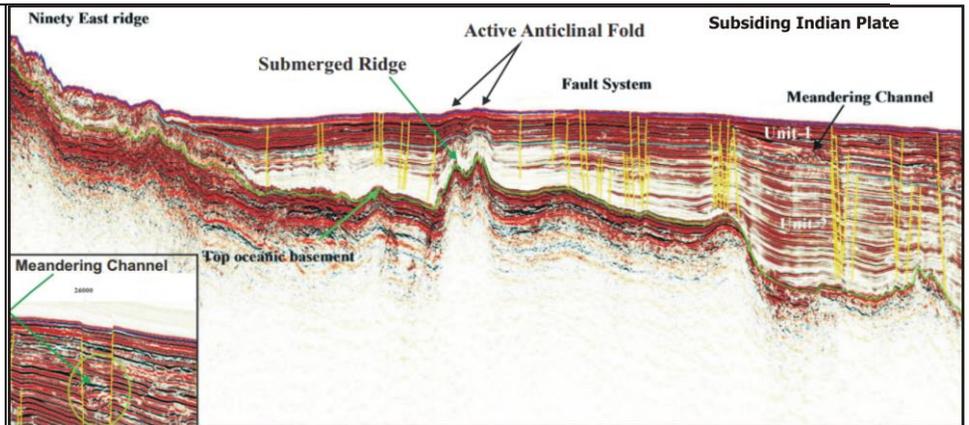


An interpreted shallow seismic section from ST-240 cruise off Ganga Delta, Bay of Bengal.

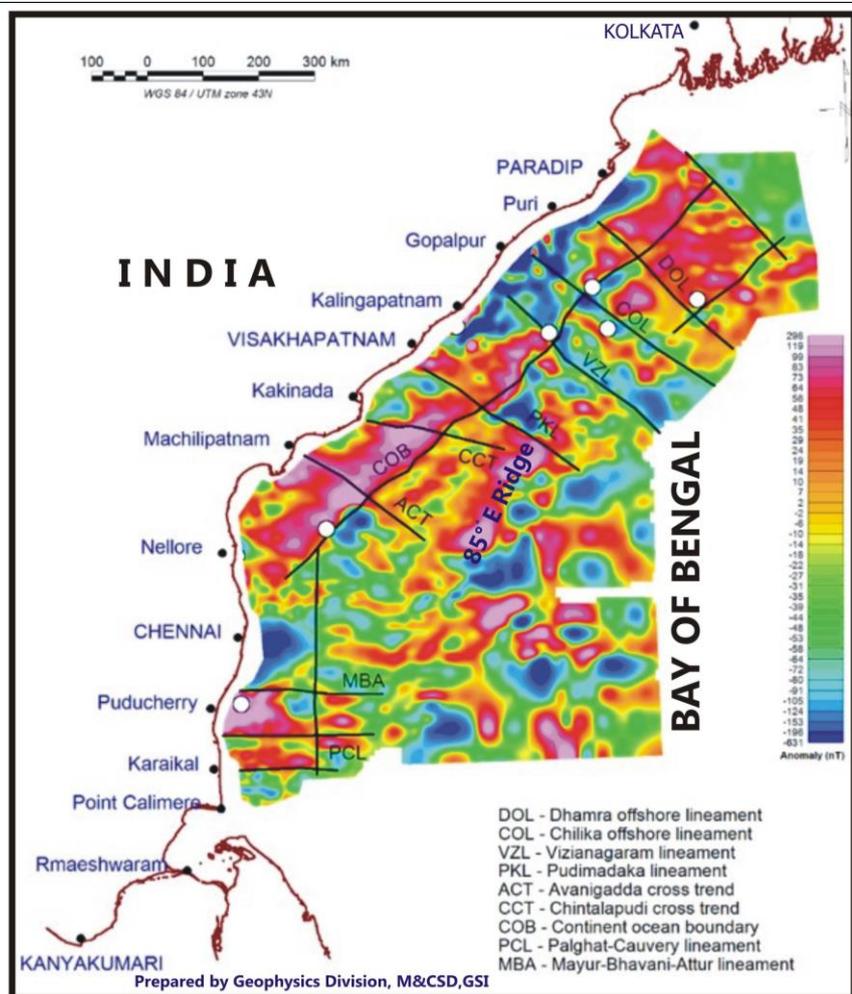


INTERPRETED ACOUSTIC REFLECTORS FOR TRAVERSE NS-3, OFF GANGA DELTA, BAY OF BENGAL

Seismogram section across the 90°E Ridge and its eastern slope towards the Sunda trench showing morphological features i.e., submerged channel & ridge, fault systems, active Anticlinal fold and rouged oceanic basement and sedimentary units off southwest of Indra Point, Great Nicobar Islands, part of transect L9, Cruise SR-019.



Magnetic anomaly map compiled from 21 cruises data acquired by research vessel of M&CSD GSI. This interpreted magnetic anomaly inferred regional tectonic features i.e., lineaments (N-S, NW-SE, NE-SW, E-W), 85° E Ridge, cross trend and continental ocean boundary present off East Coast of India, Bay of Bengal. Major onshore tectonic lineaments are extended towards the sea which are controlling the major sedimentary basins of India, located in the shelf of east coast shelf and Bengal fan. The white dots represent the location of the earthquakes in Bay of Bengal.



Free air Gravity anomaly map of SR-023 cruise off East of Barren Island, Andaman sea, showing clear demarcation of the spreading axis of Central Andaman trough and Alcock rise in region.

