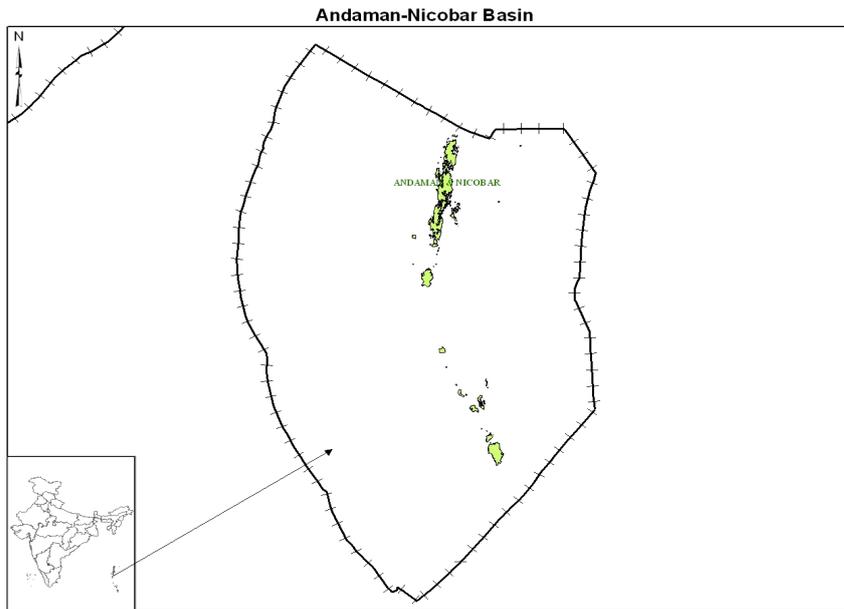
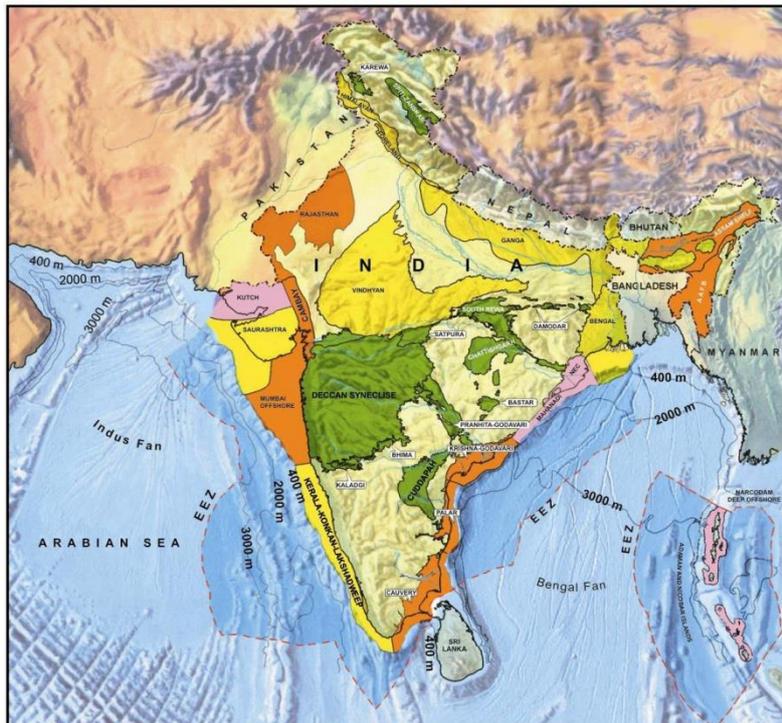


Basin Introduction:



The Andaman-Nicobar basin, located in the southeastern part of the Bay of Bengal, occupies an area of 47,000 sq. km including deep waters (Index Map Of Andaman-Nicobar Basin). This basin forms a part of Island Arc System which extends from Myanmar in the north to Indonesia in the south.

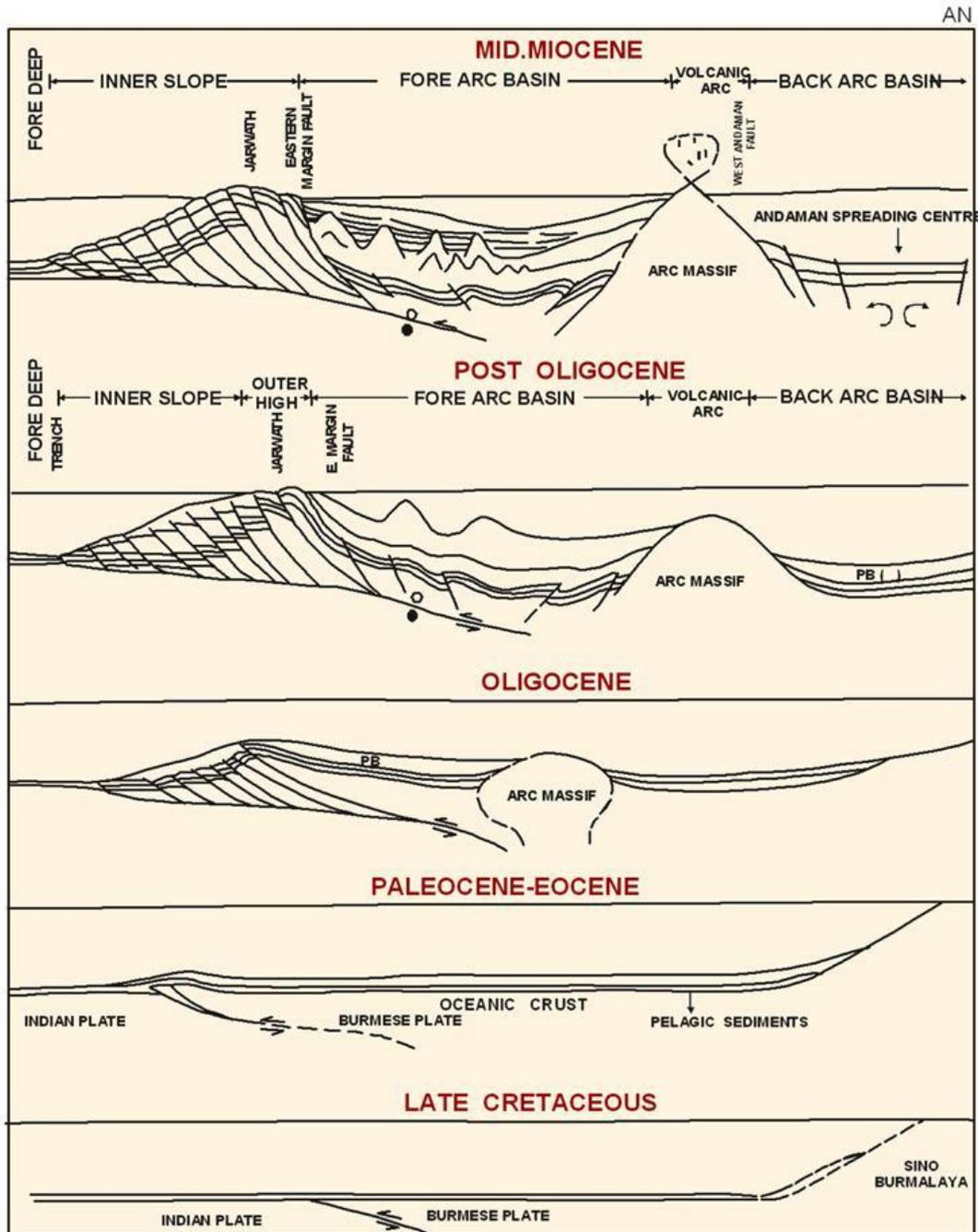


LEGEND

- | | |
|--|--|
|  CATEGORY-I BASIN
(Proven commercial productivity) |  CATEGORY-IV BASIN
(Potentially Prospective) |
|  CATEGORY-II BASIN
(Identified prospectivity) |  PRE-CAMBRIAN BASEMENT/
TECTONISED SEDIMENTS |
|  CATEGORY-III BASIN
(Prospective Basins) |  DEEP WATER AREAS
WITHIN EEZ |

The Andaman-Nicobar basin represents a typical Island arc system. The basin came into existence as a result of the northward movement and anticlockwise rotation of the Island Plate and its under thrusting under the Asian plate in the Cretaceous time. As subduction progressed, the Outer High Arc complex started rising steeply, thereby creating a depression or a Fore Arc basin between Volcanic Arc and the Outer High Arc. Continued thrusting caused uplift and formation of the Andaman Nicobar Ridge as a chain of Islands. The Andaman chain of islands form a part of geotectonic regime; " The Great Indonesian Island Arc System" of the East Indies and it extends upto Burmese Arc i.e. Arakan Yoma fold belt. It is more than 5000 km in length.

Various evolutionary stages of the Andaman – Nicobar region are shown in Fig - Evolution of Andaman Basin:Schematic Representation.



The prognosticated resources for this basin have been estimated to be about 180 MMt.

Tectonic History:.

The Andaman-Nicobar Basin has evolved through a complex history of tectonics associated with the convergent plate boundaries between Indian plate and west Burmese plate. The Andaman-Nicobar basin was initiated with northward drift of Indian Plate with respect to Asia. The collision of Indian/Eurasian plates initiated along the irregular boundary and occurred at the same time as the oceanic subduction beneath the southern Eurasia. The continental collision slowed down the oceanic spreading rates in the Indian Ocean and slowed down the subduction velocity along the Sunda Arc system. It resulted in a phase of extension in the adjacent Fore-Arc and Back-Arc areas.

Major Tectonic elements of Andaman-Nicobar region are:
 Andaman Trench/Inner slope

- Outer High/Trench slope break
- Fore Arc Basin
- Volcanic Arc
- Back Arc Basin
- Mergui Terrace

These Tectonic elements are shown in Figures:

Fig. - Schematic Cross Section across Andaman Sea at 11 degree North Latitude.

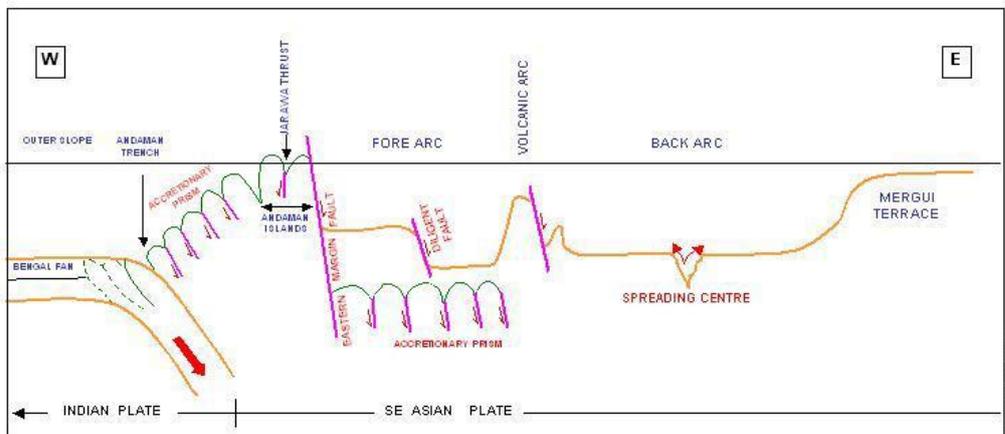


Fig. - Regional Tectonic Elements of the Andaman-Nicobar Region

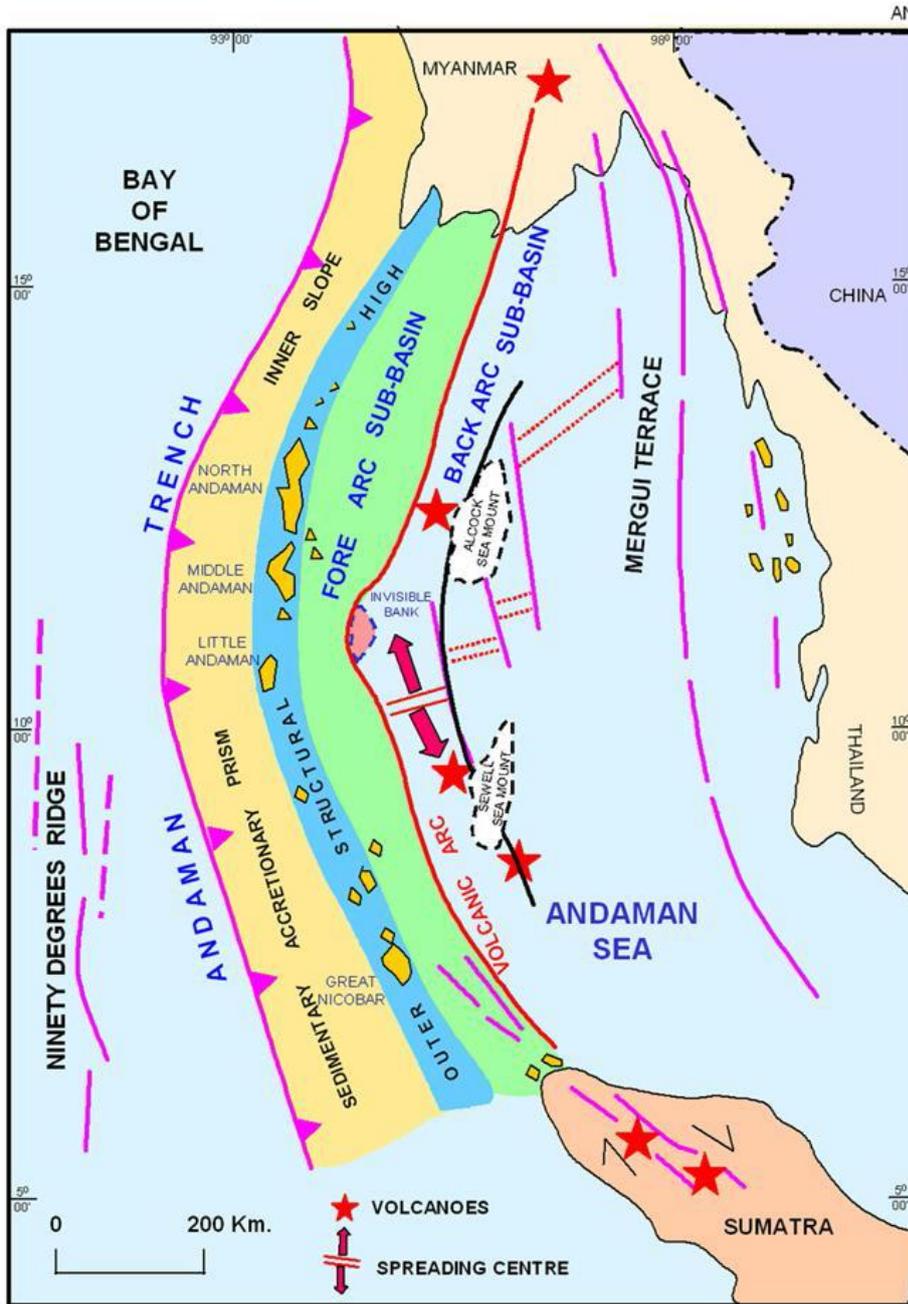


Fig. - Tectonic Map of Fore Arc Sub-Basin

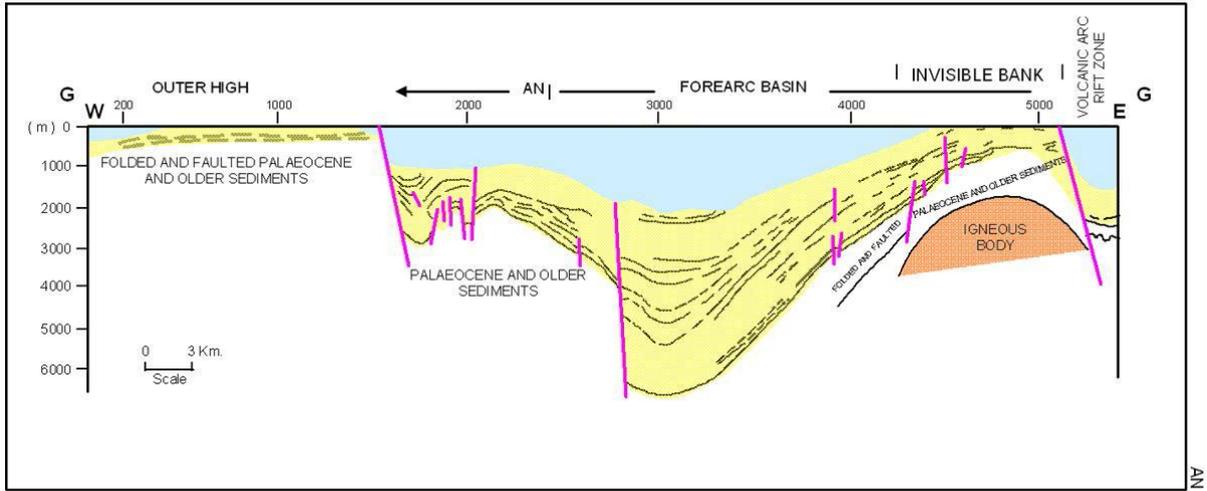
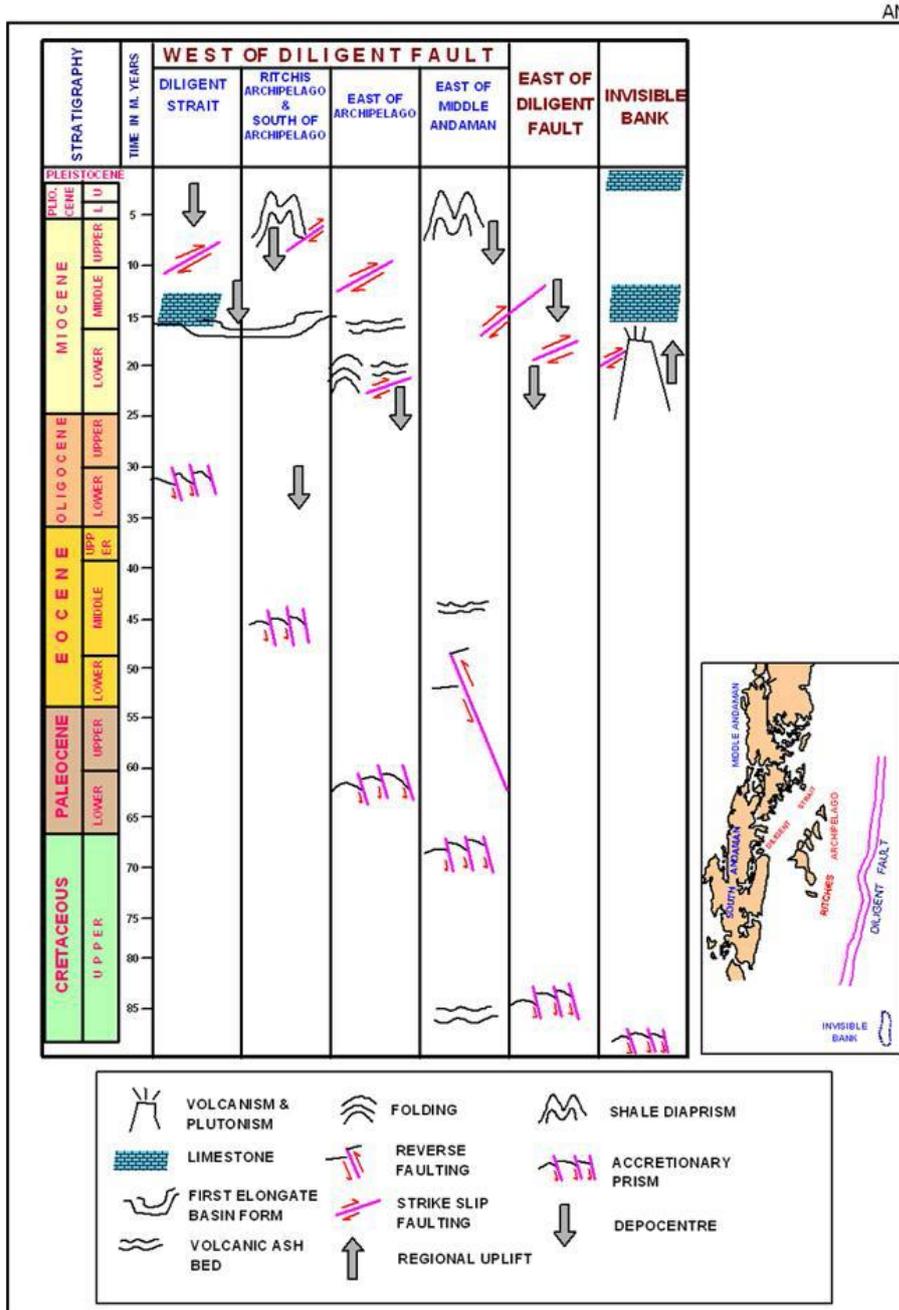


Fig. - Key Events in Development of Fore Arc Sub-Basin



Generalised Stratigraphy:

Habitat Of Oil and Gas

Tectono-sedimentation studies carried out suggest presence of various petroleum systems in Andaman basin :

1. Deeply buried thermogenic system in a ponded forearc.
2. Thermally induced petroleum system around the volcanic arc and
3. Biogenic/shallow gas system

Basins associated with convergent plate margins are known to have good hydrocarbon potential if organic carbon content and thermal maturity are satisfied. The Andaman-Nicobar basin belongs to this category. Mud volcanoes with associated oil and gas are reported from the outcrops of the Baratang Formation over the Middle and South Andaman. Gas has been discovered from Middle Miocene limestone in well AN-1-1. Minor gas indications have also been observed from the Lower Miocene vitric ash beds of well AN-32-1 (Lithostratigraphic Column of Well AN-32-1)

AN

AGE	DEPTH (m)	LITHOLOGY	DESCRIPTION	ENVIRONMENT OF DEPOSITION
EARLY MIOCENE	300	[Lithology: Clay / Claystone with volcanic ash]	MAINLY CLAY / CLAYSTONE AND CALCAREOUS SILTSTONE ADMIXED WITH VOLCANIC ASH	OUTER SHELF TO BATHYAL
	600			
	900	[Lithology: Clay / Claystone with volcanic ash and limestone streaks]	CLAY / CLAYSTONE ADMIXED WITH VOLCANIC ASH AND OCCASIONAL LIMESTONE STREAKS	MOSTLY MIDDLE SHELF AND OCCASIONALLY INNER SHELF
	1200	[Lithology: Alternation of claystone, shale, limestone, and marlstone]	ALTERNATION OF CLAYSTONE / SHALE, LIMESTONE AND MARLSTONE	MOSTLY OUTER SHELF, ALSO MIDDLE SHELF AND SHELF AND BATHYAL
	1500	[Lithology: Mainly claystone / shale with vitric ash, mudstone, and limestone streaks]	MAINLY CLAYSTONE / SHALE WITH VITRIC ASH, MUDSTONE AND THIN STREAKS OF LIMESTONE	FLUCTUATING FROM INNER SHELF TO BATHYAL
1800				
2100				
2400				
TD 2510 m				

as well as from Cretaceous sandstone of AN-1-1 well Lithostratigraphic Column of Well AN-1-1.

AN

AGE	FORMA-TION	DEPTH (m)	LITHOLOGY	DESCRIPTION	REMARKS
PLEISTOCENE AND YOUNGER	N E I L	500			
PLIOCENE	L O N G	1000		Claystone with minor sandstone and limestone	
LATE MIOCENE		1500			
MIDDLE MIOCENE		2000			
OLIGOCENE		2500		Argillaceous limestone with minor sandstone	★ (Discovery) 180,000 m ³ /day
LATE CRETACEOUS TO EOCENE	K A L A P A N I	3000		Claystone with minor sandstone	
		3500		Alternation of sandstone and shale	★ (Indication)

TD 3734 m

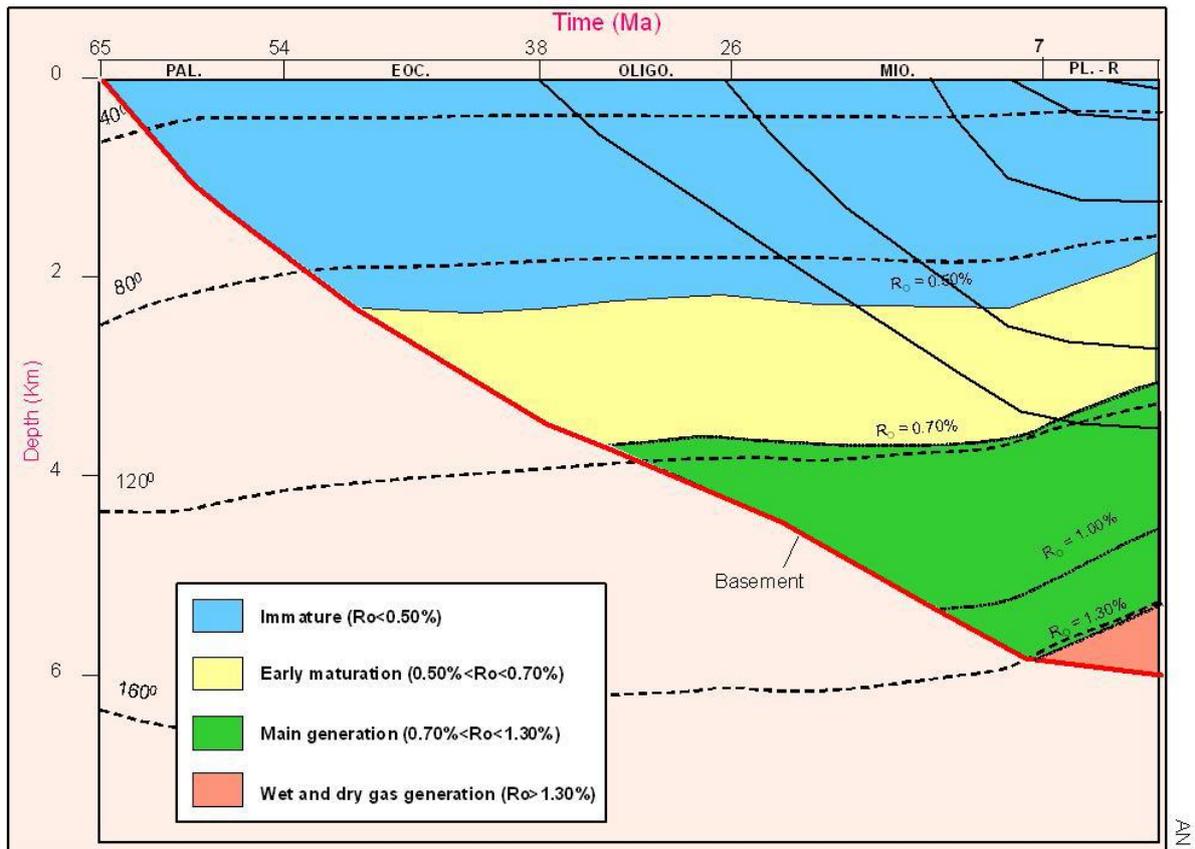
Sedimentary packages, specially in the Fore Arc basin, comprise strata of fluvial, shelf and deep marine regime. Accumulation of significant organic matter is considered a strong possibility. Possible reefal growths within the Neogene section, further enhance the scope of enrichment of organic matter. Proximity of the Fore Arc basin to the Volcanic arc is likely to ensure optimum heat flow for hydrocarbon generation.

The Inner slope has been the locale for Paleogene turbidite deposition that is known as collector of rich organic matter. Similarly, the Back Arc zone has been an area with significantly high heat flow and thus considered favourable for hydrocarbon generation.

Geochemical analyses have indicated that Andaman-Nicobar region has organic rich sediments. The total organic carbon (TOC) ranges between 2.4% & 5.2% for Cretaceous to Oligocene Shales and Claystones.

The most favorable source rock in the basin appears to be the Baratang Formation of the Late Cretaceous-Late Eocene age, comprising of shale, silt, sand, carbonaceous shale, limestone with minor anhydrite and gypsum deposited in bathyal to shallow marine and open to restrictive euxinic environments. The Pre-Neogene section in well AN-1-1 indicated presence of rich organic matter. The Baratang Formation is in the early phase of maturation and lies within the principal phase of oil generation up to 5,000 m. Geochemical modeling has been carried out by M/s LARGE of Russia, using data from drilled wells as well as pseudo wells generated in deep water area. A is shown

in Representative Thermal & Maturation History in Deep Waters of Andaman-Nicobar Basin.



The Neogene sequence, though immature for any significant thermogenic generation of hydrocarbons, is of interest for biogenic gas (as observed in the limestone of Well AN-1-1).

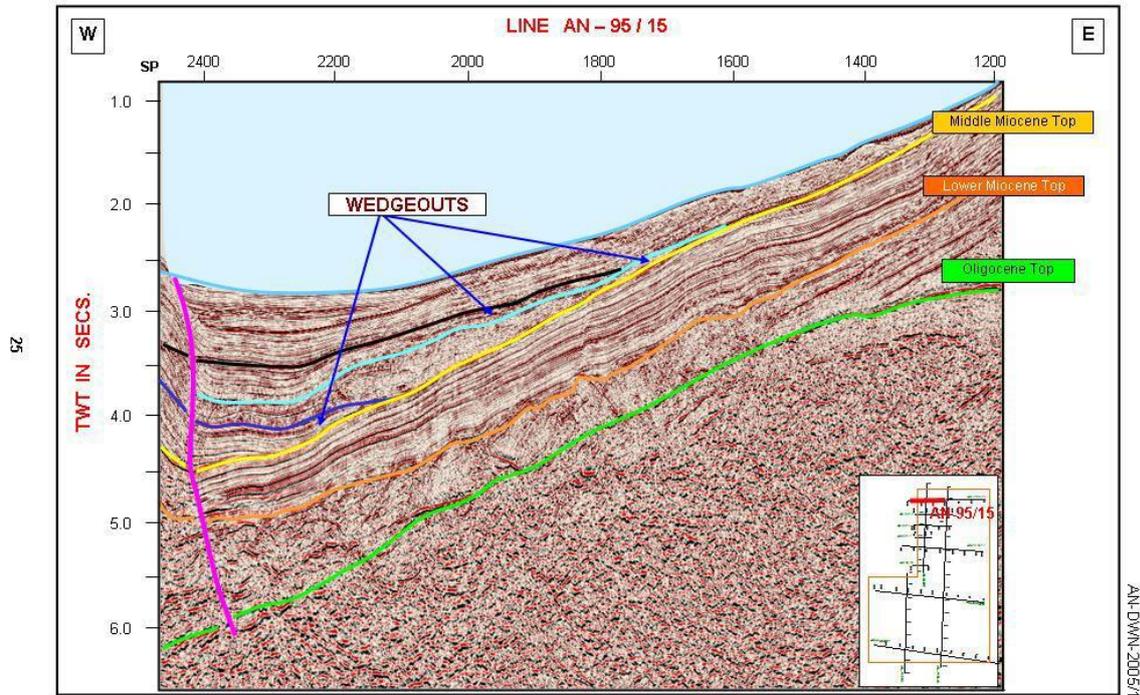
Port Blair Formation, which is the main reservoir facies in the basin, shows variable properties. Over the Andaman Islands, the reservoir rock is conglomeratic and pebbly at places, with alternating silty sand and shale or fine to medium grained massive sand stone at other places. Sandstone reservoirs appear to be restricted to the Middle Miocene. Drilling results indicate that the main reservoir is Carbonate. The major Carbonate platform shoal provinces of the Middle and Lower Miocene were generally located in periphery of the Central Uplift. The Paleogene section in the outcrops of the Outer High and in the subcrops of the Fore Arc basins and Inner Slope contains turbidite deposits. The presence of carbonate deposits at higher stratigraphic levels are associated with development of reefal characters in the Sumatra Fore Arc region.

In the Andaman – Nicobar basin, the inner slope has not been probed by much of exploratory drilling so far. A large number of anticlinal structures within the Cretaceous-Oligocene sequence with fairly good source and reservoir facies, form excellent entrapment conditions (Fig.

Porosity pods within Tertiary limestones constitute excellent reservoirs in offshore Sumatra (Meulba-1) and in offshore Andamans (AN-1-1). To the east of south Andamans, onlapping sedimentary sequences over the slope of magmatic arc provide ideal entrapment conditions for accumulation of sizeable hydrocarbons deposits. Porous facies in the carbonate section of Neogene is well developed in the northern part of Andaman Fore Arc basin. Southward extension of this element harbours large oil/gas fields in northern Sumatra (Arun gas field). Occurrence of fairly large anticlinal structures provides suitable entrapment conditions for hydrocarbon accumulation.

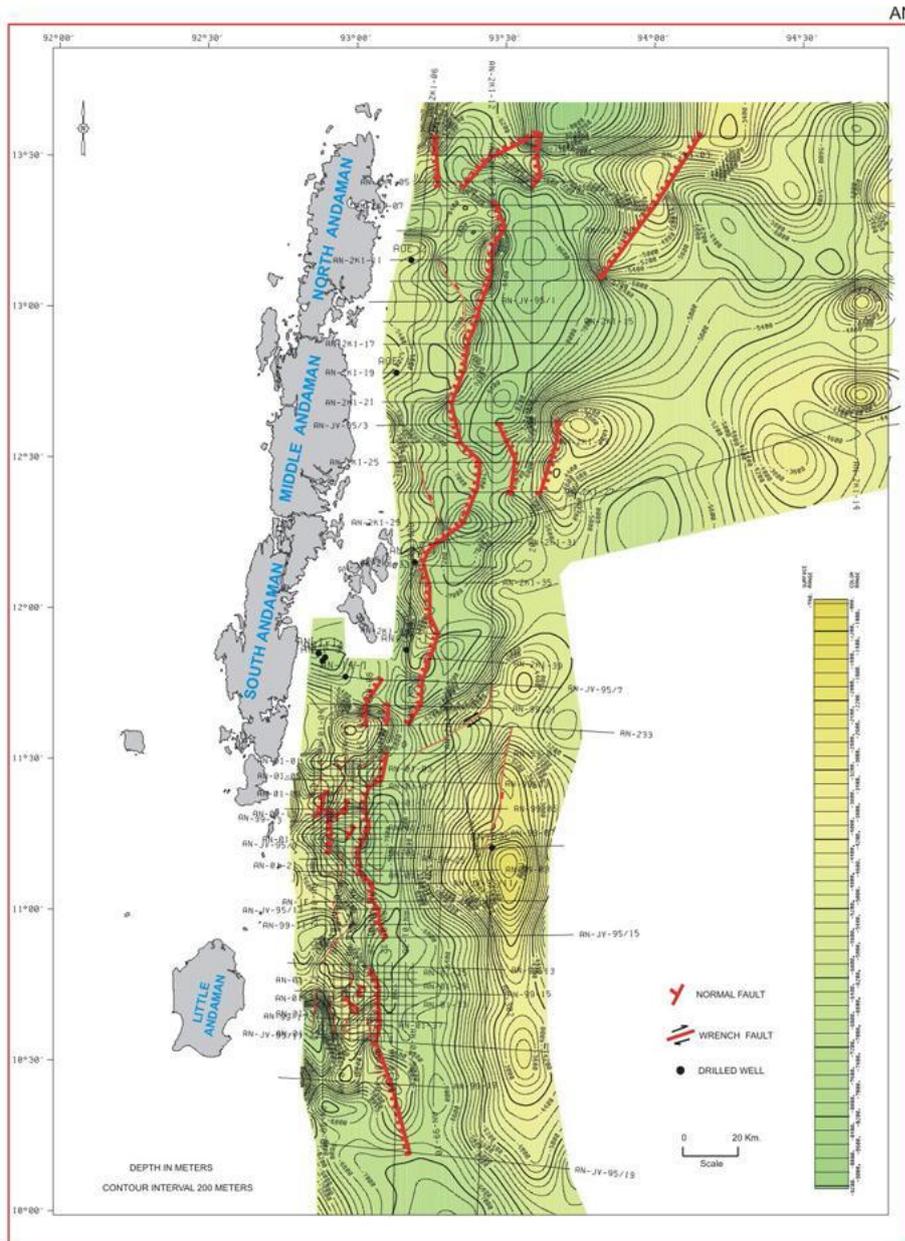
In the invisible bank area, the onlapping sedimentary sequences on the flanks are ideal locales for pinchout / wedgeout features favouring entrapment.

Anticlinal / Fault related structures are the principal type of traps for accumulation of hydrocarbons – primarily gas – in Post Oligocene sediments. Stratigraphic traps like pinchouts, wedgeouts, reefs, turbidites etc. are considered to be potential traps for hydrocarbon accumulations (Wedgeouts in Miocene Sequence).



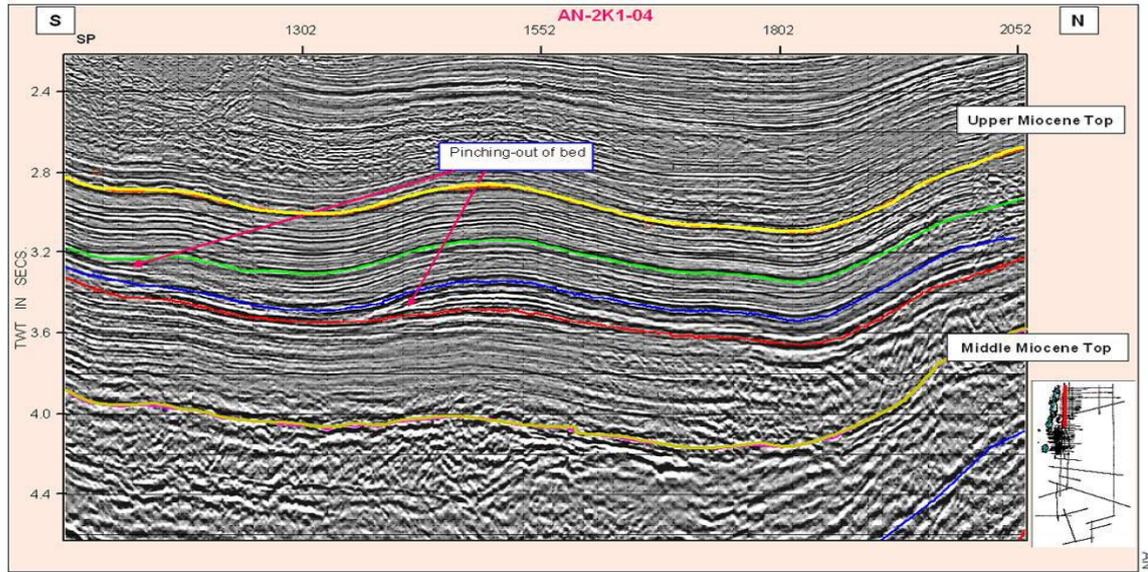
A number of small size anticlinal structures with relief of 150m to 200m / fault related structures are indicated at the level of Pre-Oligocene(Basement ?). These anticlinal features are reflected in Miocene sediments also (Structural Contour Map on top of Middle Miocene)

& (Structural Contour Map on top of Basement).

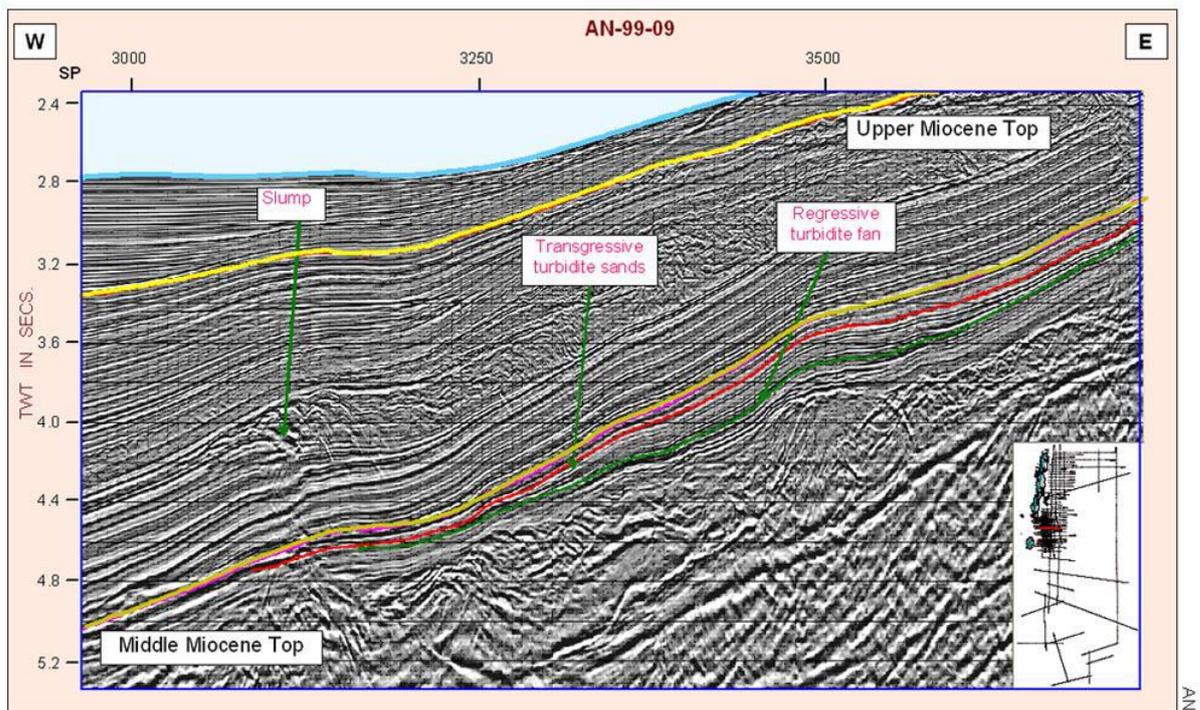


Stratigraphic Traps

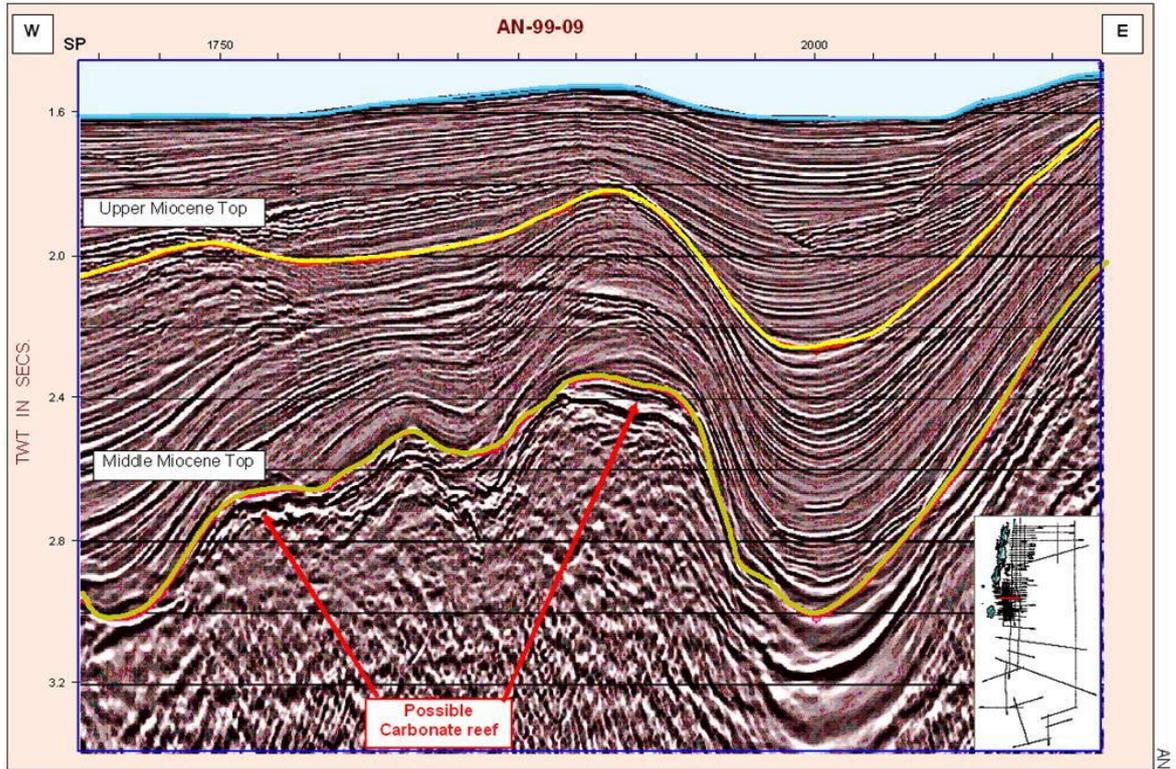
- Pinchout of Beds of Upper Miocene Sequence



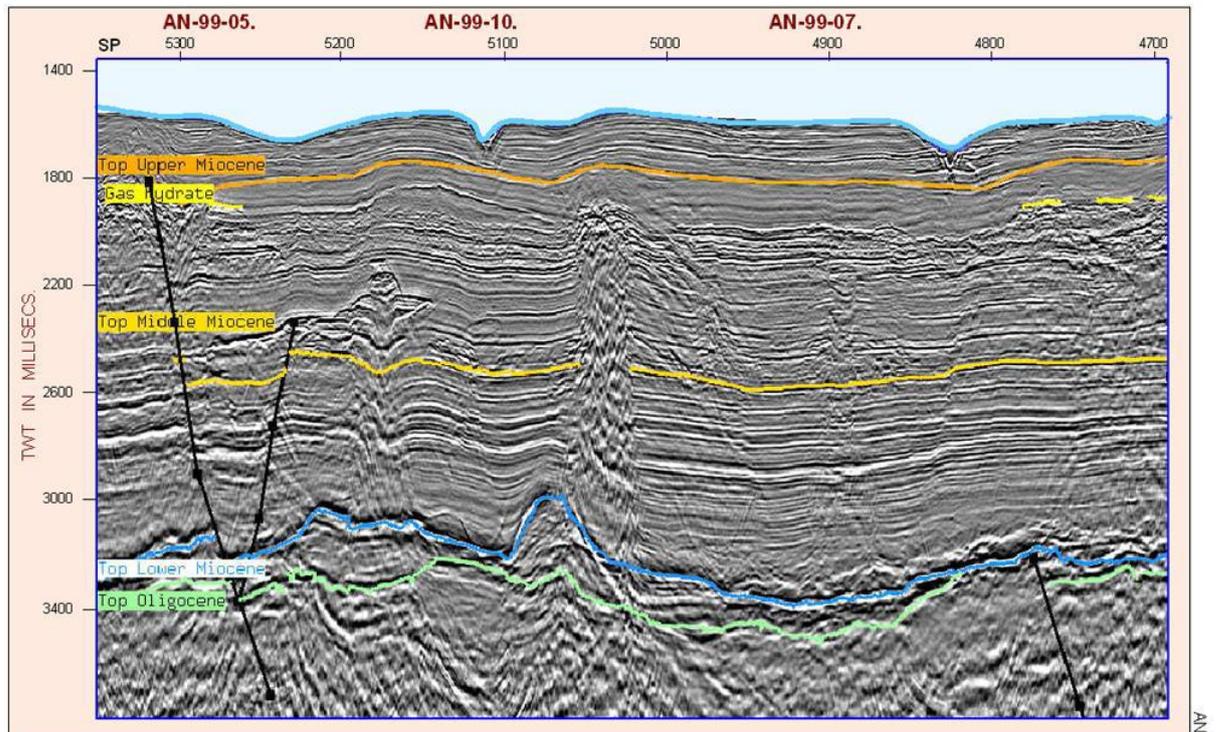
- Possible Slump and Turbidite sands in Upper and Middle Miocene Sediments



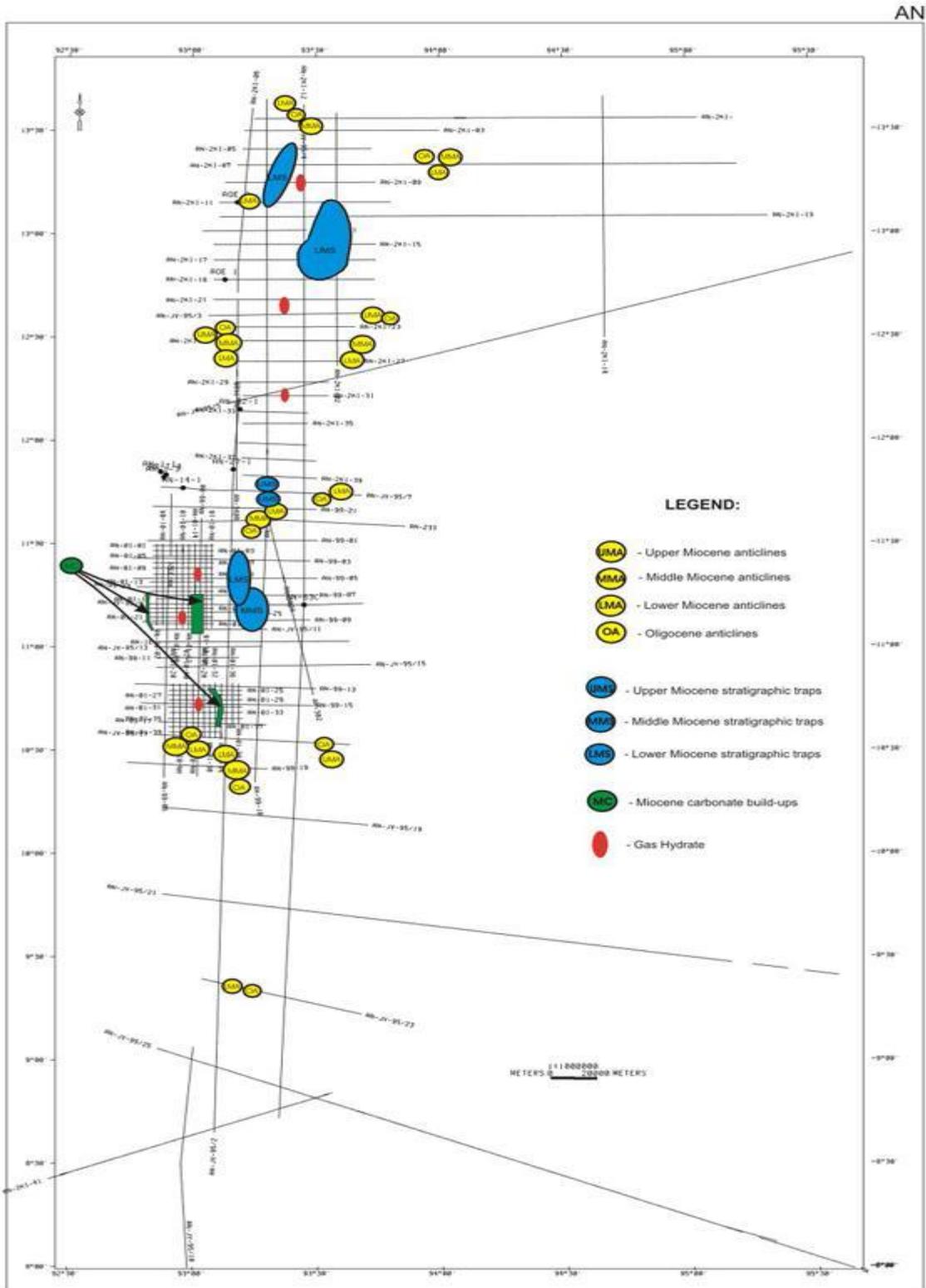
- Possible Carbonate Reefs (bioherms) in Middle Miocene sequence



- Shale Diapirism in Lower Miocene



Some of the Hydrocarbon Prospects identified in Andaman-Nicobar Basin



The above work has helped in establishing of broad stratigraphic and structural framework of the Andaman-Nicobar area. Over 3,000 m of sediments ranging in age from Cretaceous to Recent are exposed. Three major unconformities have been identified. The main Andaman and Nicobar islands expose mostly rocks of Cretaceous-Oligocene age. The Neogene strata are exposed mainly in the Ritchie's Archipelago. Generalised Lithostratigraphy of Andaman Islands .

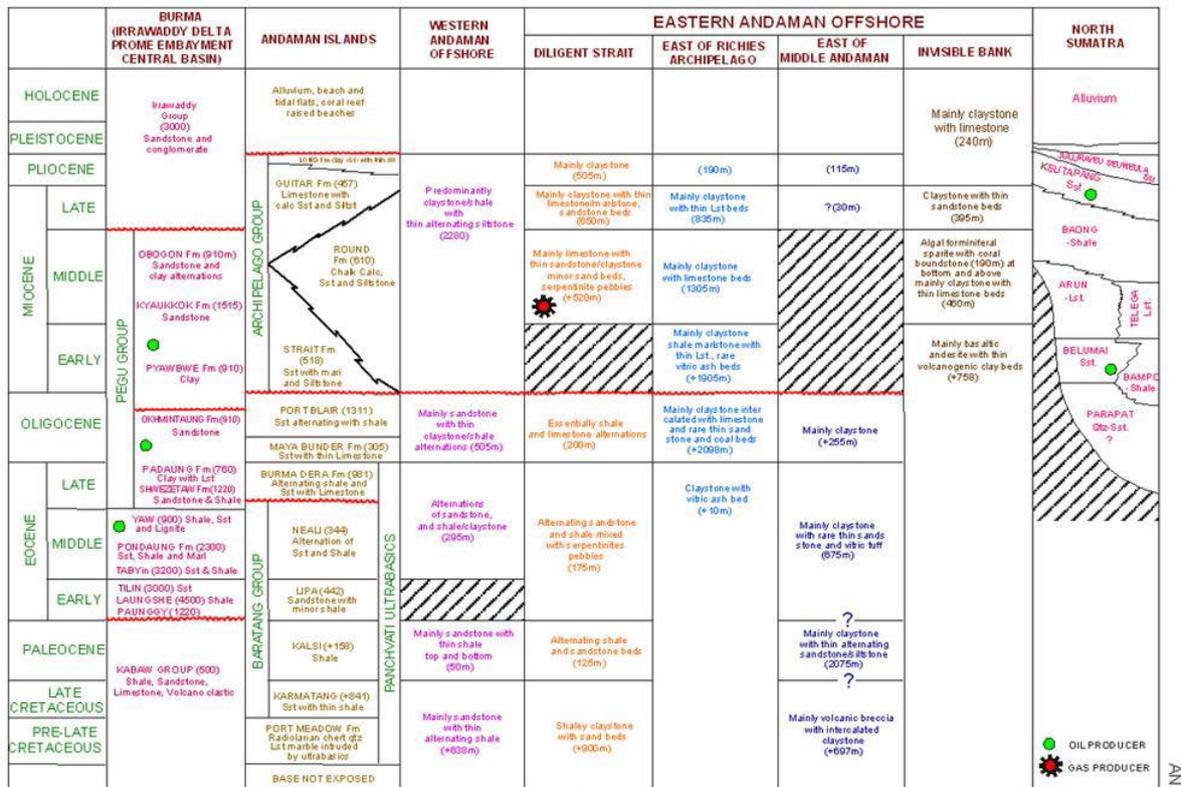
AN

AGE	FORMATION	THICK. (m)	LITHOLOGY	LITHOLOGICAL DESCRIPTION	
PLEISTOCENE	NEIL FM.	45		MEDIUM HARD BUFF COLOURED, FINE TONED GRAINED FOR LISAL GAL, BIOCALCARINITE	
MID. MIOCENE PLIOCENE	LONG FM.	1450		GREY MASSIVE MUD STONE, SILTY SHALE, HARD LIMESTONE	
EARLY-MID. MIOCENE	INGLIS FM.	280		NANNO FORAM CHALK, SILTY SHALE, SHALE	
EARLY MIOCENE	STRAIT FM.	90		SANDY LIMESTONE SOFT MARAL TUFF SLICES CHALK SILT CALC. BANDS	
OLIGOCENE	PORTBLAIR FORMATION	1000		GT. BW. BUFF TO LIGHT GREY SANDSTONE WITH GREY BUFF WATER BEDED SILTSTONE AND SHALES, GRITS AND CONGLOMERATE AT THE BASE	
E O C E N E T O C R E T A C E O U S	BARATANG FORMATION	BURMA DERA	410		MAINLY SHALE WITH SANDSTONE MARL SILTSTONE WITH WATERBEDED CLAYSTONE WITH MINOR LIMESTONE OCCASIONAL ULTRABASIC INTRUSION
		NEALJ ALTE- RNATION	318		ALTERNATION OF SANDSTONE AND SHALE WITH MINOR LIMESTONE, CONGLOMERATE WITH MINOR COAL AND OCCASIONAL ULTRA BASIC INTRUSION
		LIPA SANDSTONE	452		SANDSTONE, CONGLOMERATE GRIT BEDS AND MINOR SHALES WITH OCCASIONAL ULTRA BASIC INTRUSION
		KALSI SHALE	260		GREY TO DARK GREY CARBONACEOUS SHALE, CLAYSTONE, SILTSTONE AND INTERCALATION SANDSTONE
		KARMATANG SANDSTONE	846		SANDSTONE CARBONACEOUS AND PHYLLITIC SHALE & LIMESTONE WITH ULTRABASIC INTRUSION
PRE CRETACEOUS	PORT MEADOW FM.			QUARTZITES, PHYLLITE, CHERT, JASPER SLATE CHERTY LIMESTONE AND MARBLE	

Not to scale

The stratigraphy of onland basin has been derived from the surface geological mapping on various islands along with data obtained from 14 shallow wells. The data obtained from 14 exploratory wells drilled in the offshore region has been considered for evolving the generalized stratigraphy of the basin, which is shown in

Fig. General Stratigraphic Correlation of Burma, Andaman and North Sumatra & Fig. Generalised Subsurface Stratigraphy of Andaman-Nicobar Basin.

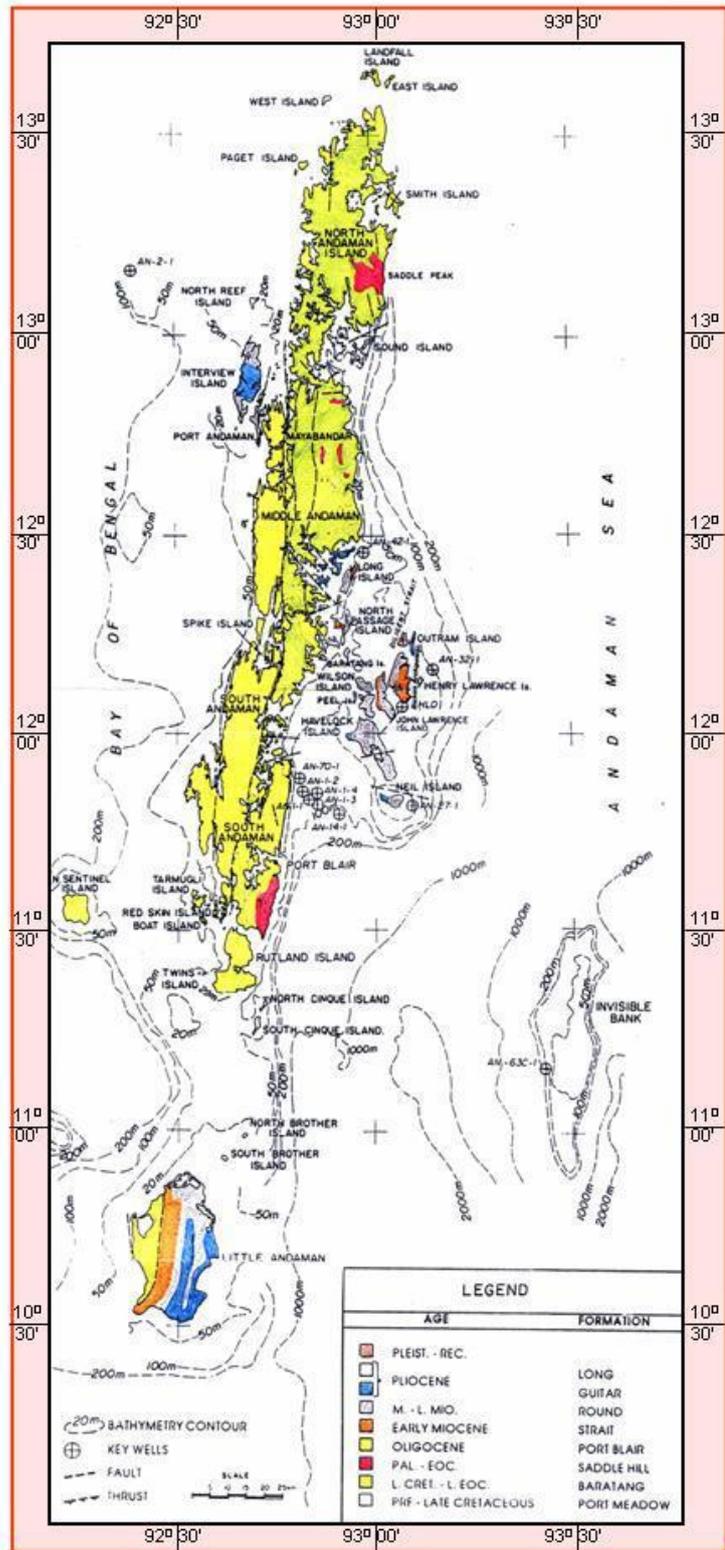


Information on subsurface stratigraphy has been obtained by exploratory drilling of 11 wells in the eastern offshore and 1 in the western offshore. Out of these 12 wells, 8 wells ended in Pre-Neogene section and remaining wells at different levels within the Neogene section. Well data indicate a wide variation in stratigraphy & lithological constituents.

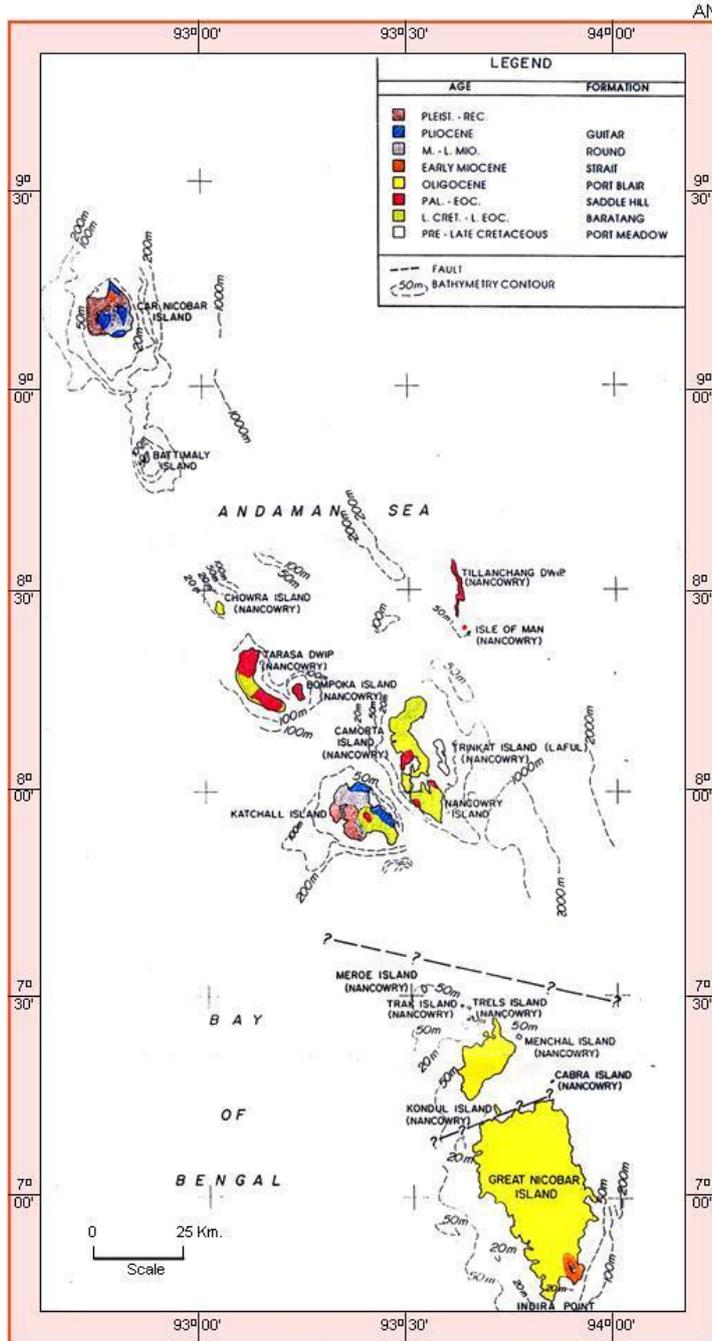
Status of Exploration:

Exploratory activities in the basin by ONGC commenced in 1959 with the initiation of geological mapping. Since then, 5433 sq.km of area has been covered by reconnaissance, semi-detailed and detailed mapping, and 646 LKM by traversing. The geology of the islands is shown in Fig. Geological Map of Northern part of Andaman-Nicobar Basin

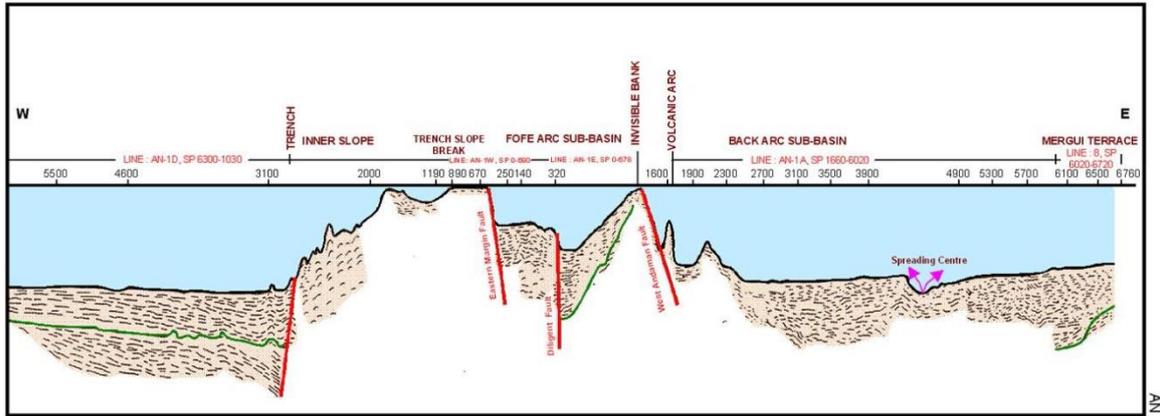
AN



& Geological Map of Southern part of Andaman-Nicobar Basin



. A Geological Section across the Andaman-Nicobar Basin.



Geophysical surveys in the offshore areas of the Andaman-Nicobar Basin were initiated by ONGC in 1977. To start with, ONGC acquired 6,370 LKM of 24 fold CDP data through Dresser Olympic in 1977. This was followed by acquisition of 1,898 LKM of 24 fold data through M/s. GSI in 1979 and 10,039 LKM of 48 fold data through M/s. GSI in 1982 in Eastern and Western Andaman area. Thereafter, 2,426 LKM of 24 fold data in 1988 and 2,831 LKM of 72 fold data was acquired in 1990 in the areas East and South of Andaman through M/s. GECO. The surveys by GECO having high quality of seismic data, helped in detailing of the Neogene prospects identified earlier and in mapping of additional prospects within the Pre-Neogene section.

DGH has acquired 7,906 LKM of high resolution seismic data during 1997–2001 through Western Geophysical and M/s. LARGE of Russia.

The quantum of geophysical data acquisition till date, by ONGC, OIL and DGH is 27356 LKM, 201 LKM and 9,398 LKM respectively, totaling to 36,955 LKM.

In addition to the above 7,314 LKM of gravity data and 17,775 LKM of Magnetic data have also been acquired.

DGH, has carried out Satellite Gravity Survey over Andaman offshore area through M/s Petroscaan, Germany, covering about 0.292 million sq. km. Derived Bouguer gravity map based on Satellite Altimetry and depths to the base of sediments derived from the above gravity map are shown in Fig. Derived Bouguer gravity map based on Satellite Altimetry : Andaman Offshore

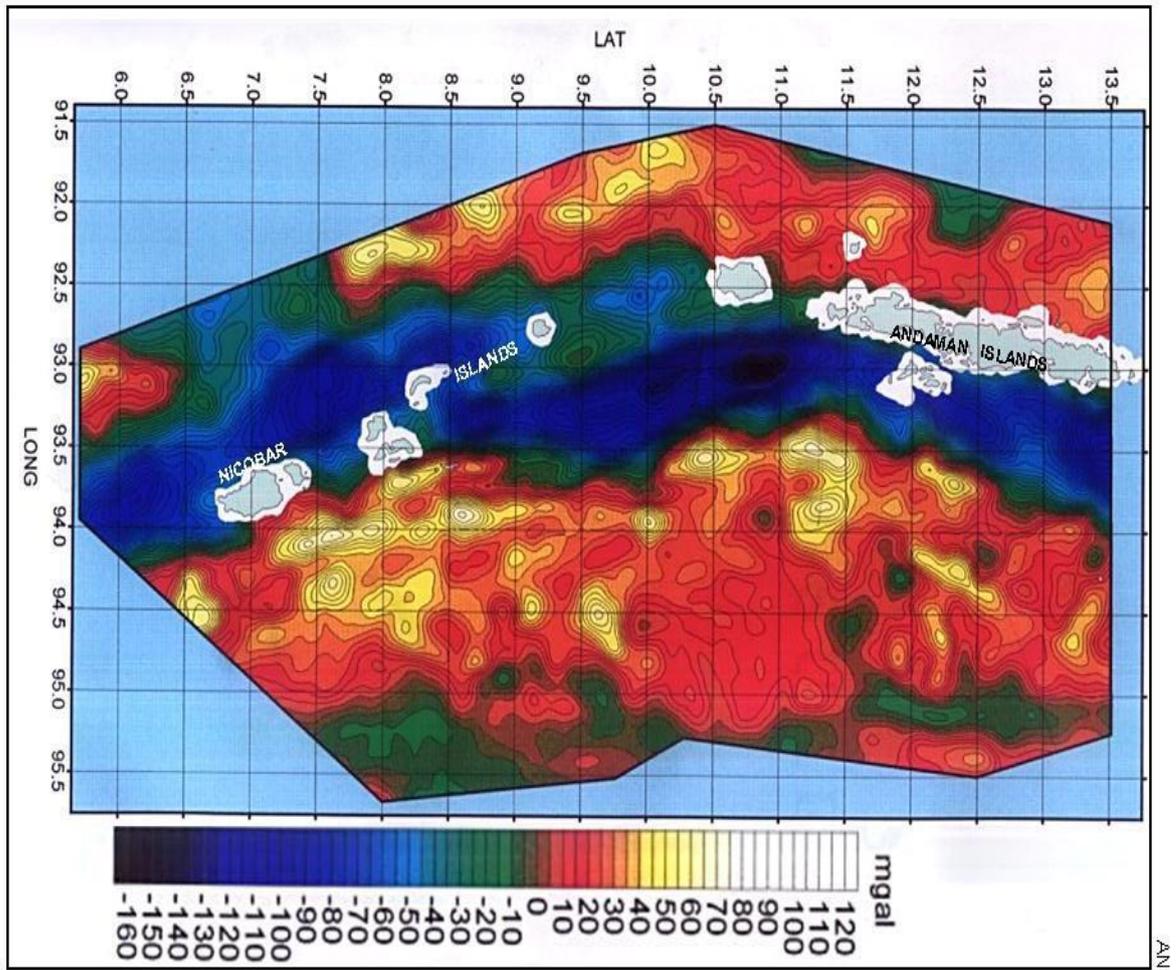
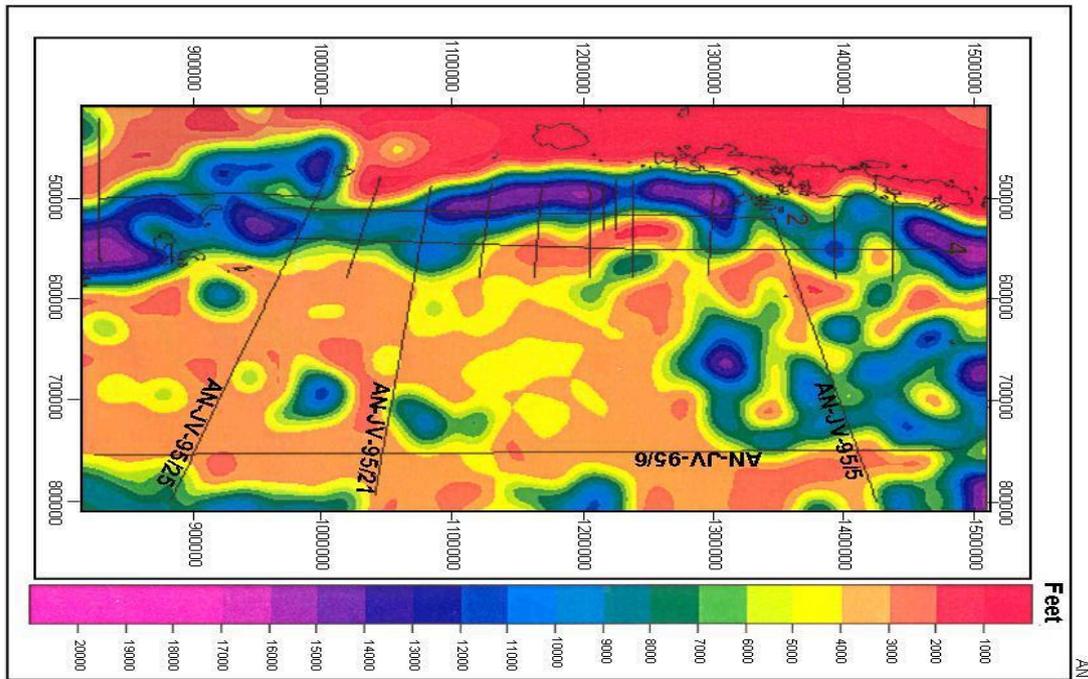


Fig. Depths to Basement from 3D Gravity Inversion.



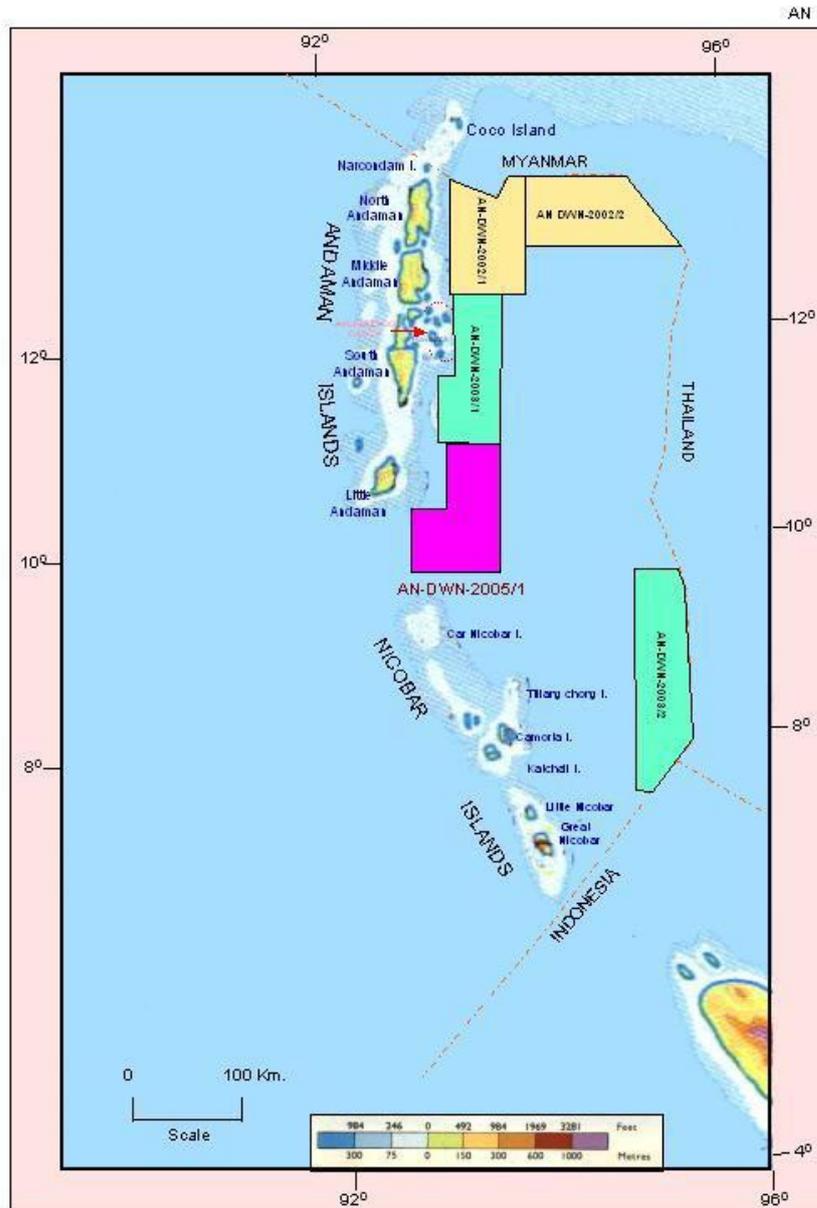
These maps depict the arcuate nature of fault zones, which is a reflection of the arcuate nature of westerly subduction zone.

The first exploratory well AN-I-I, drilled in 1980, resulted in discovery of gas flowing @ 180, 000 m³ / day from Middle Miocene limestone. A total of 15 exploratory wells have been drilled in the Neil and Havelock Islands., 1 of which lies in the western and the remaining are in the eastern Andaman offshore. Indications of gas from Early Miocene sediments were recorded in a number of wells.

In 1988, 2,500 LKM of sniffer surveys have been carried out in the eastern Andaman offshore. Interpretation of the results obtained from absorbed gas survey indicates the presence of wet gas in these recent sediments suggesting occurrence of reservoirs in the subsurface. Several positive anomalies have been brought out by Geochemical sniffer surveys. Recent seismic data acquired in deep waters has revealed attractive exploration targets in carbonate buildups in Eocene – Miocene sequences and turbidites & gas hydrates in Neogene sequence.

Two exploration blocks in deep waters, namely, **AN-DWN-2002/1** & **AN-DWN-2002/2** offered under NELP-IV round have been awarded to Oil & Natural Gas Corpn. Ltd. (ONGC). Another two exploration blocks namely, **AN-DWN-2003/1** and **AN-DWN-2003/2** were offered under NELP-V round. These blocks were awarded to ONGC and ENI-ONGC-GAIL consortium respectively. Under NELP-VII round one block is being offered in Eastern Andaman

Fig. Exploration Blocks in Andaman-Nicobar Basin.



. Geophysical data acquisition carried out in these PSC blocks as on 31.05.2008 is tabulated below :

Block name	2D (LKM)	3D Q-marine (SKM)	RP(2D LKM)
AN-DWN-2002/1	1400	2541	1400
AN-DWN-2002/2	2600	2702	2600
AN-DWN-2003/1	2900	205.5	1000
AN-DWN-2003/2	5141	2528	1066

Hydrocarbon Potential:.

Mud volcanoes with associated oil and gas shows are reported from the outcrops of the Baratang Formation of the Middle and South Andaman.

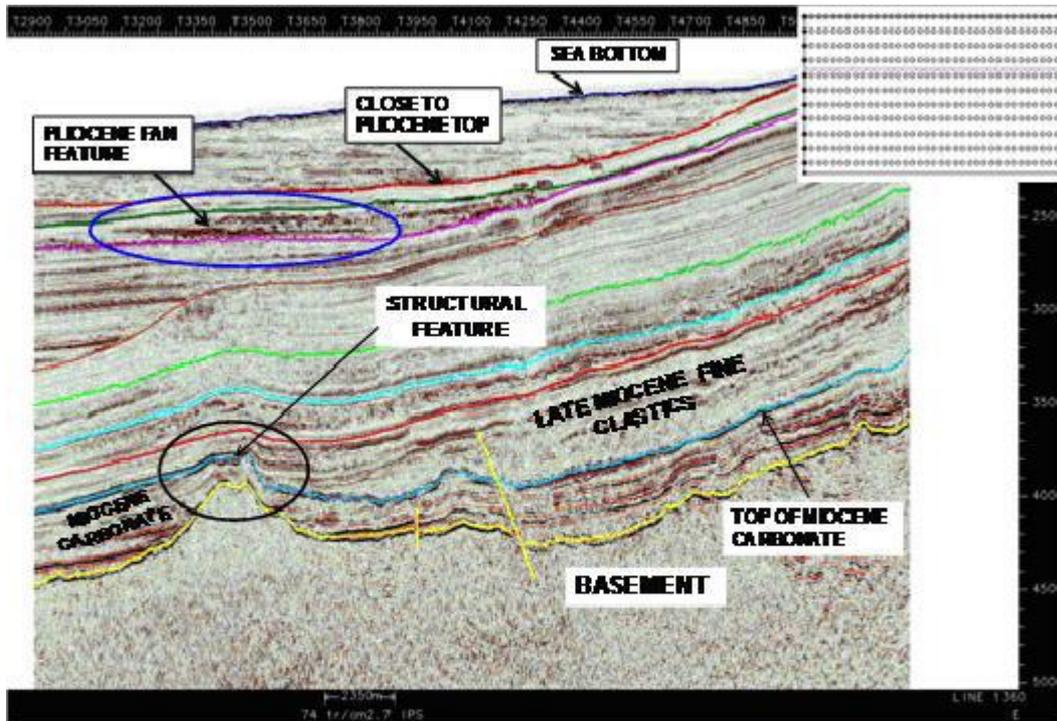
Gas discovery from Middle Miocene limestone in well AN-1-1 proves that hydrocarbons have been generated in the Inter-deep basin of east Andaman shelf. Minor gas indications have also been observed from the Early Miocene vitric ash beds of well AN-32-1 as well as from Cretaceous sandstone of AN-1-1 well. The data from well AN-63C-1 indicate that good to mature organic matter having Kerogen Type-II & III is present in the Pre-Neogene section. In the little Andaman Island, gas seepage is associated with Miocene sediments.

From the presence of commercial hydrocarbons in the adjoining basins of similar geological setting, this basin is considered to have fairly rich hydrocarbon potential.

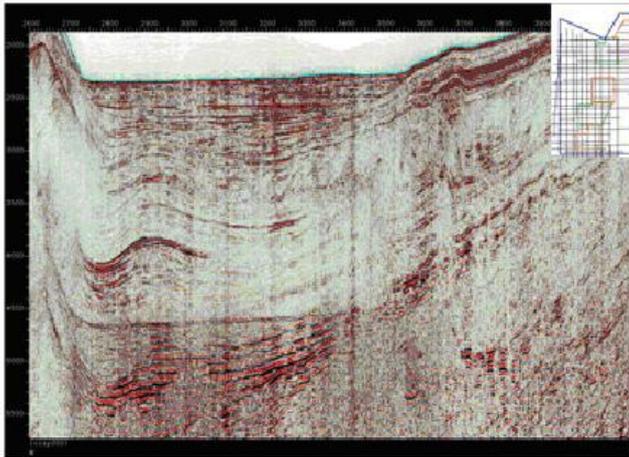
NELP-IV Block: AN-DWN-2002/1

Based on the interpretation of G & G data including extensive 2D seismic data over the area of 10,990 Sq. Km. of the block and subsequently 3D Q marine seismic data of 881 SKM data under Area I of the block, few play types has been identified which are **structural, strati-structural and purely startigraphic plays**. The prospects under different plays are mainly the carbonate platform, carbonate build-ups, inversion within ponded fill areas and channel - levee - fan complexes. Few prospects are shown below :

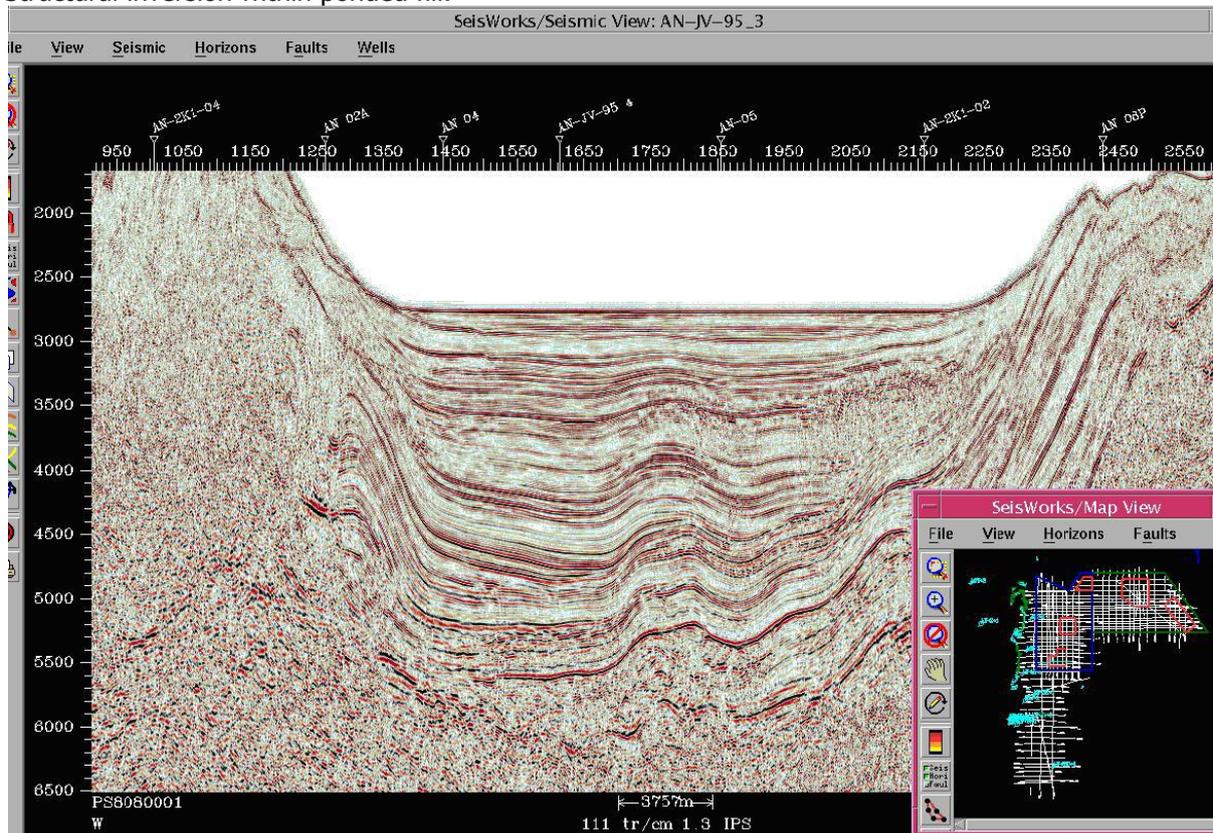
Seismic section along 3D line showing Platformal Carbonate.



Seismic line showing showing anticlinal feature with Possibility of fault closure.

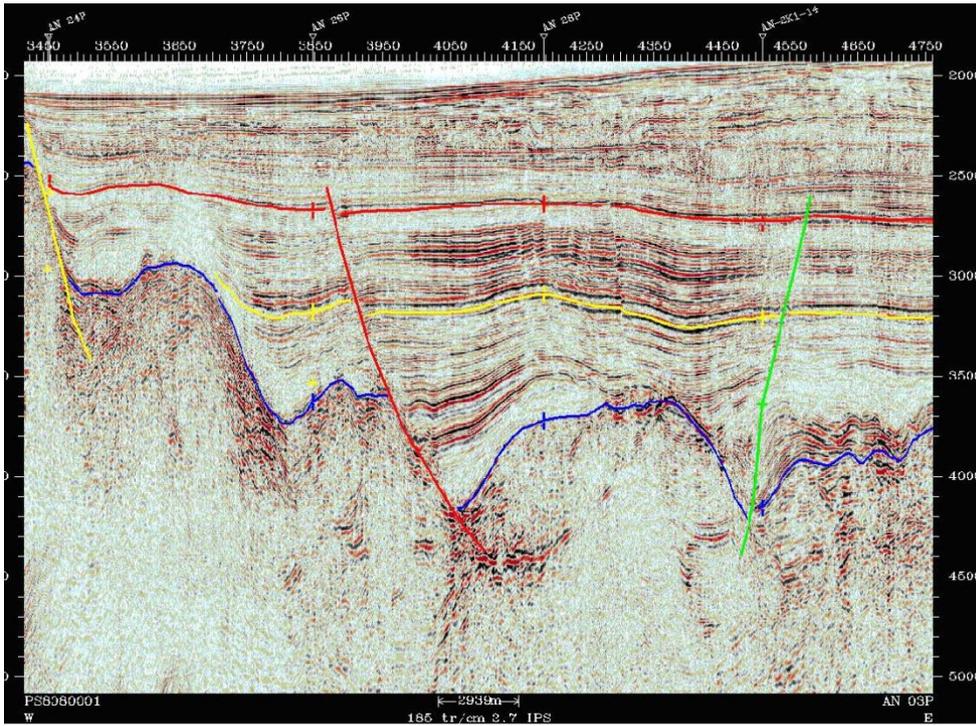


Structural inversion within ponded fill.

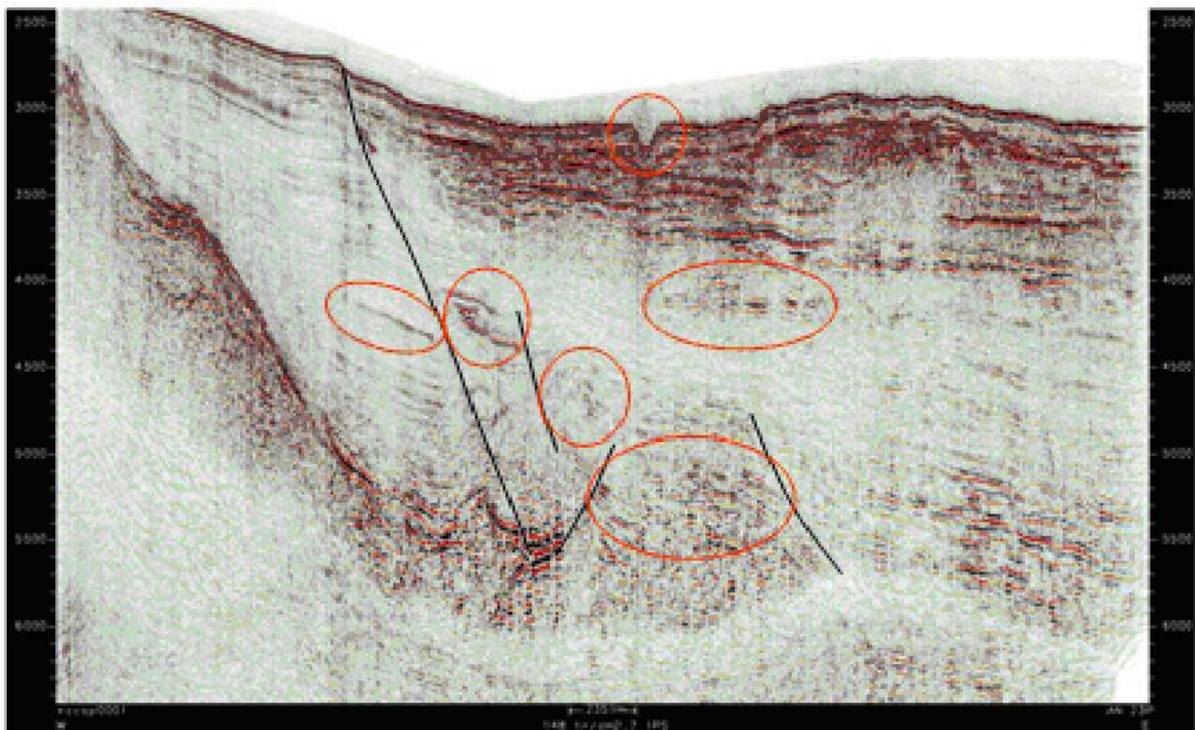


Major portion of the eastern part of the block AN-DWN-2002/2 is occupied by the volcanic Arc, whereas the SE part forms a back arc basin. Based on the interpretation of G & G data including extensive 2D seismic data over the area of 12,495 Sq. Km. of the block and subsequently 3D Q marine seismic data of 1135 SKM data under Area I & II of the block, few prospects have been identified and are shown below :

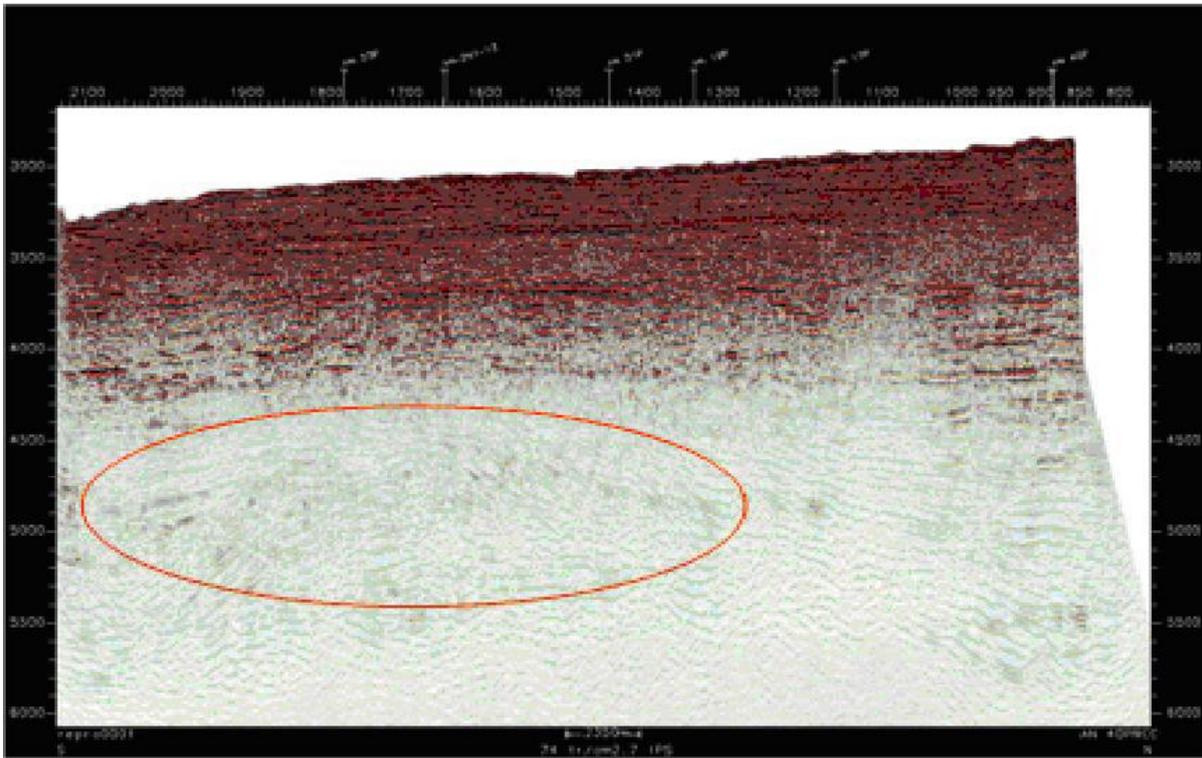
Seismic section showing rift fill and structural inversion.



High amplitudes associated with fault and Fault aided anticline in the back arc setting.



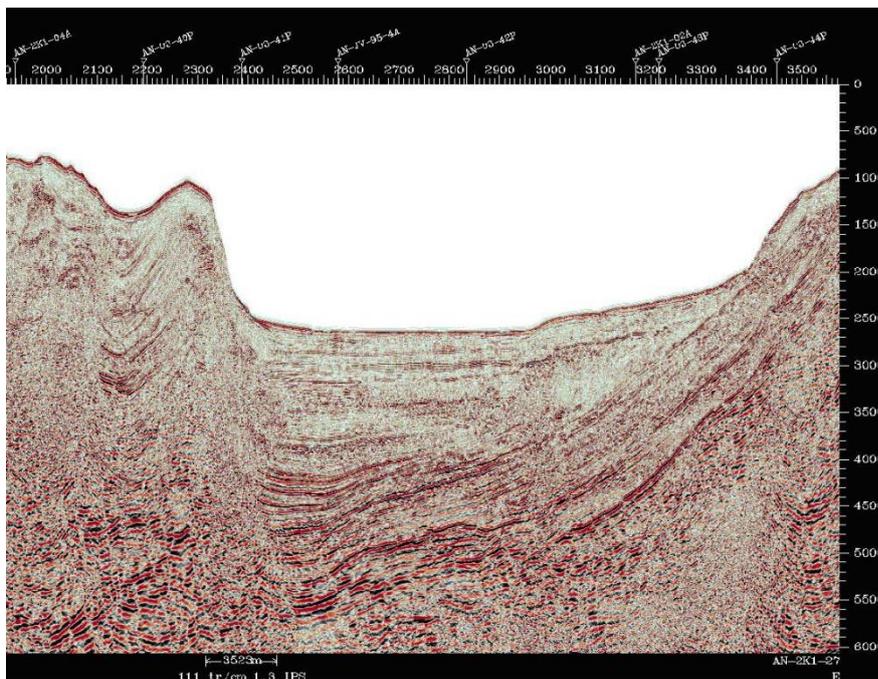
N-S line confirms a four way closure.



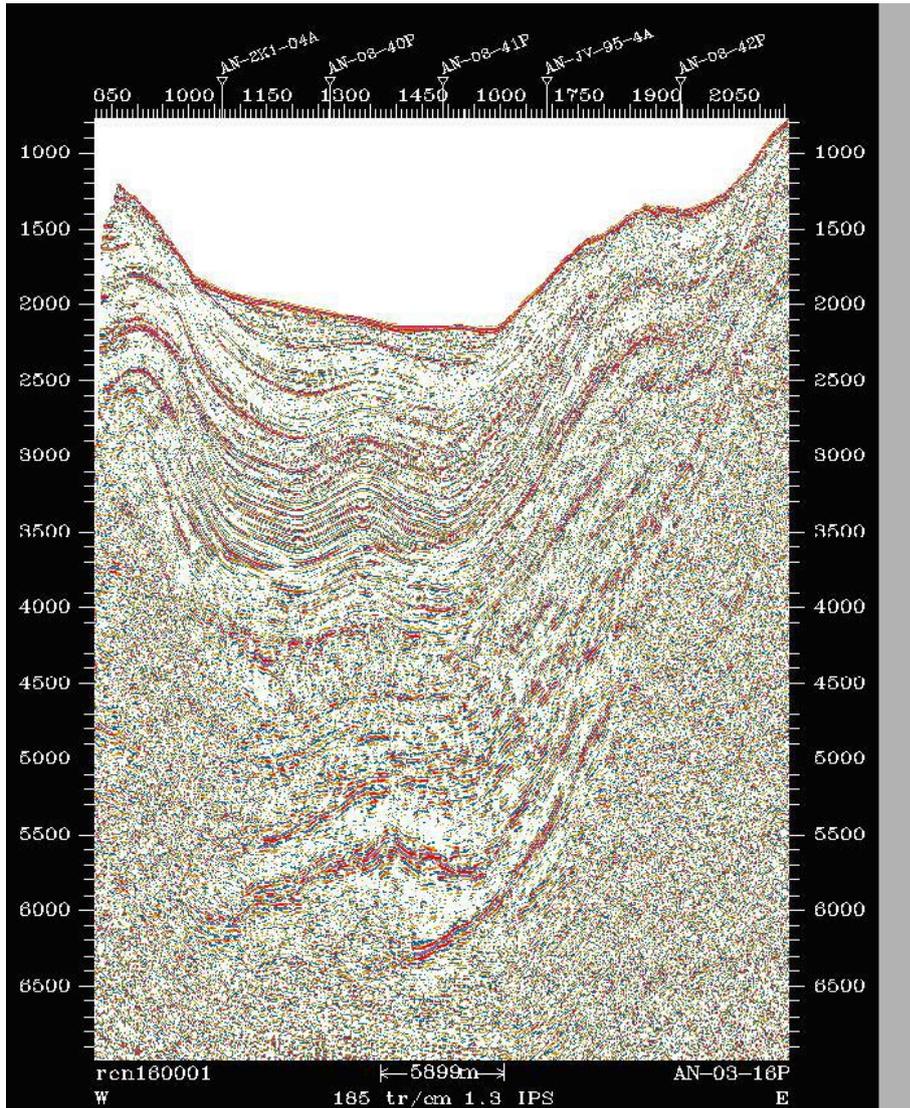
NELP-IV Block; AN-DWN-2003/1

Based on the interpretation of G & G data including extensive 2D seismic data over the area of 9970 Sq. Km. of the block, few prospects have been identified and are shown below :

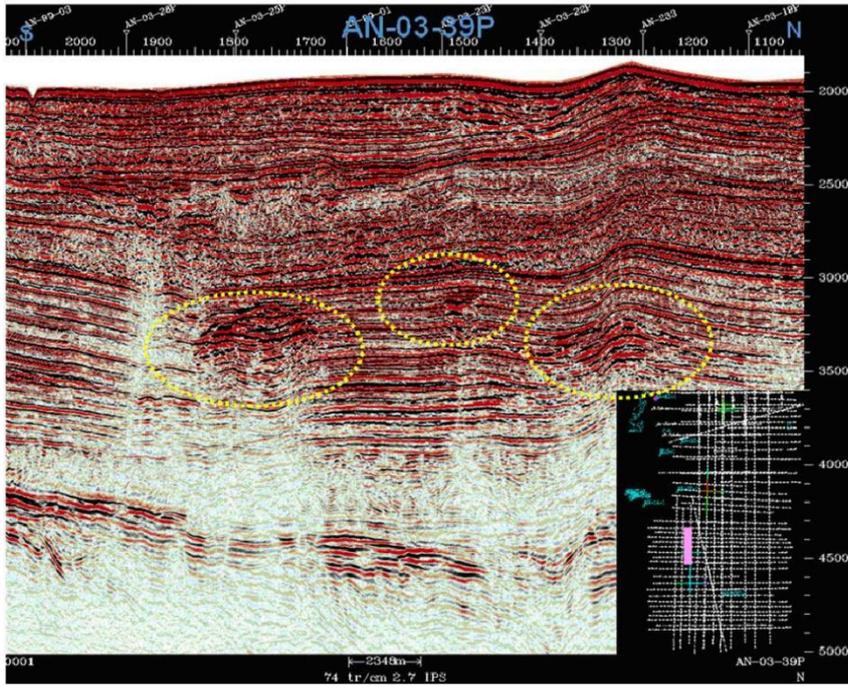
A mound like feature showing good seismic anamoly



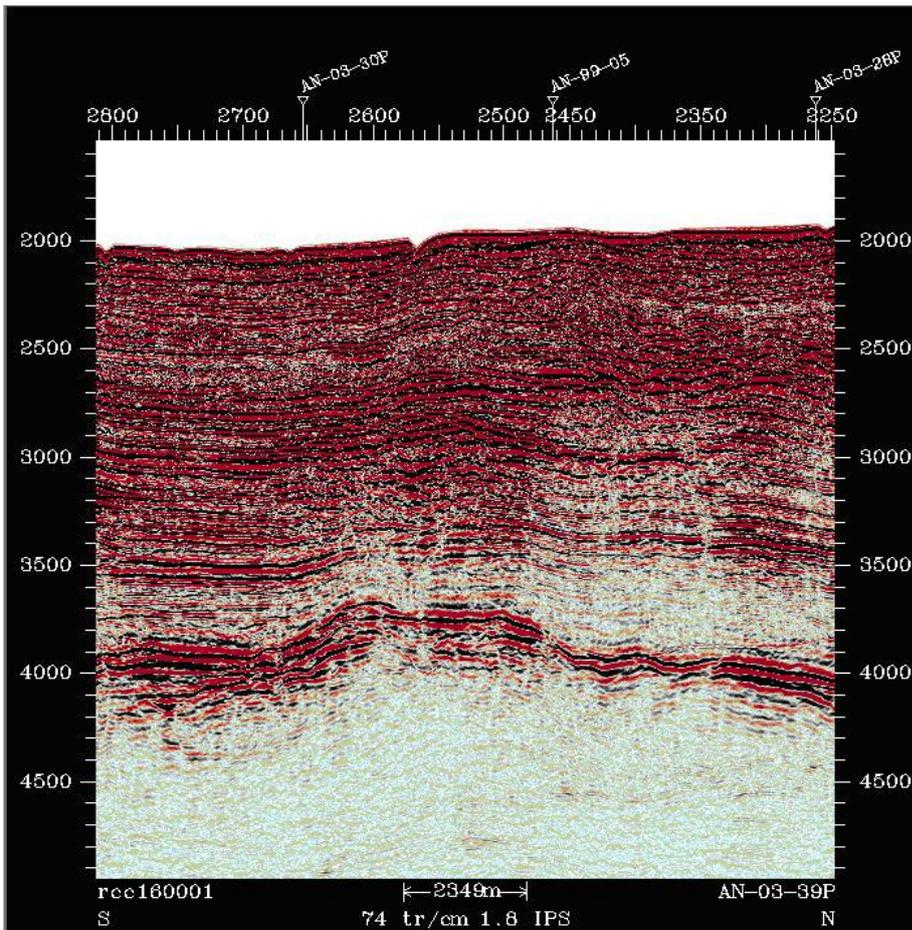
An anticlinal prospect with structural inversion.



Series of seismic anomalies along N-S line.



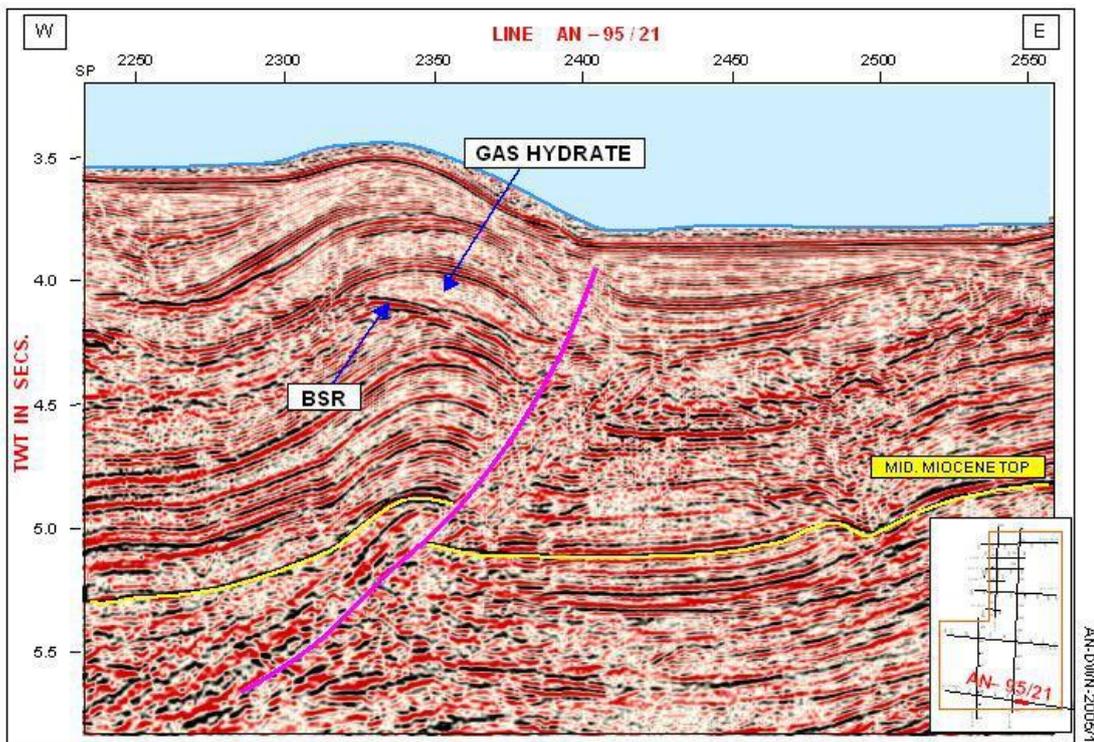
Seismic anomaly over basement arch.



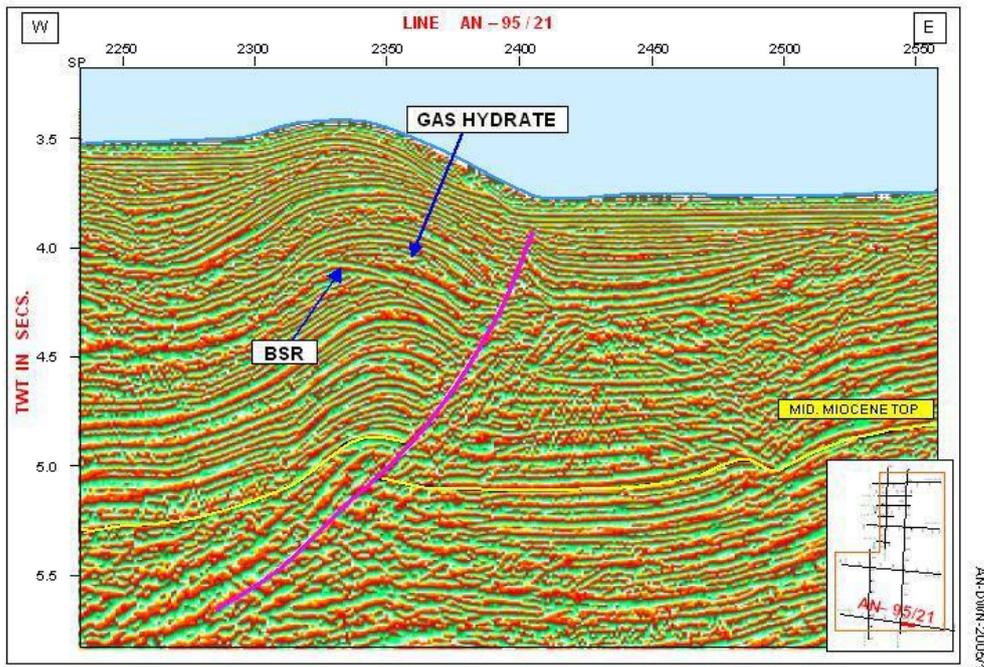
Gas Hydrates in Andaman Region:.

The occurrence of gas hydrates is inferred from the presence of the Bottom Simulating Reflector (BSR). Assessment of their potential is one of the most controversial questions in the scientific study of hydrocarbon generation.

Seismic Section having indication of BSR



Instantaneous Phase Version showing BSR



Hydrate as a seal to free gas in the area East of South Andaman

