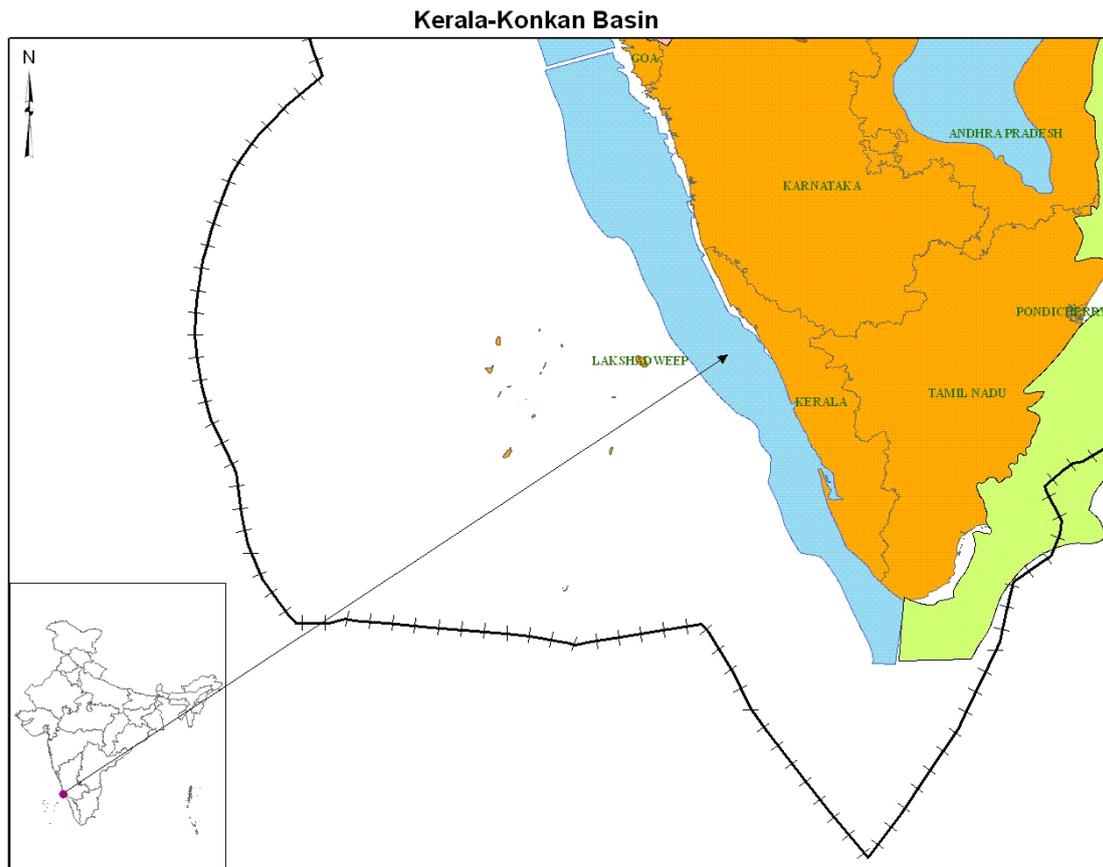


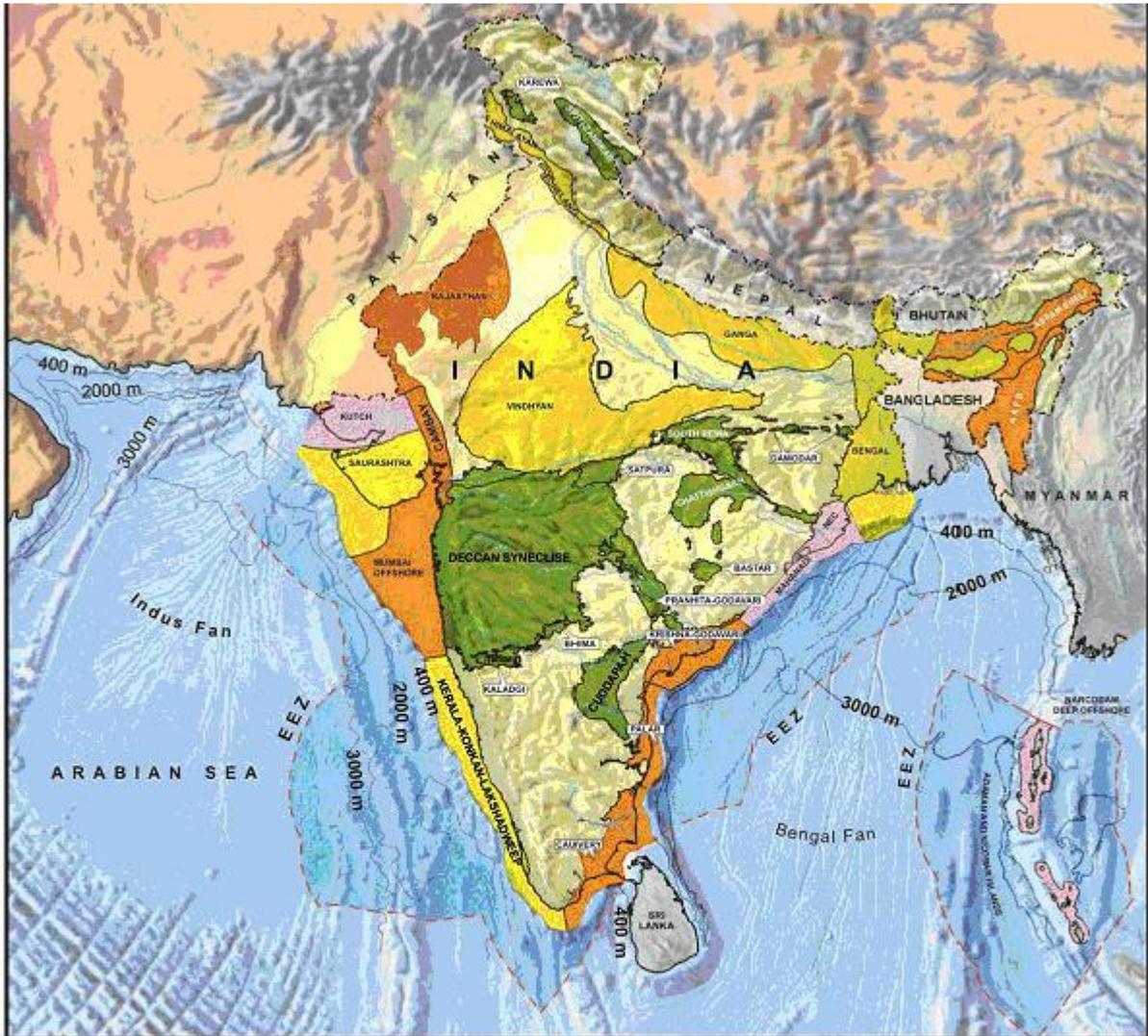
Basin Introduction .:



Geographic Location of the basin

The Kerala-Konkan basin is located at South of 16 degree N latitude. The Kerala-Konkan offshore basin forms the southern part of the western continental margin of India and extends from Goa in the north to Cape Comorin in the south. Westward, the basin extends to the Arabian Abyssal plain. On the eastern side, it is bounded by the peninsular shield.

[Geographic Location of Kerala-Konkan Basin](#)



LEGEND

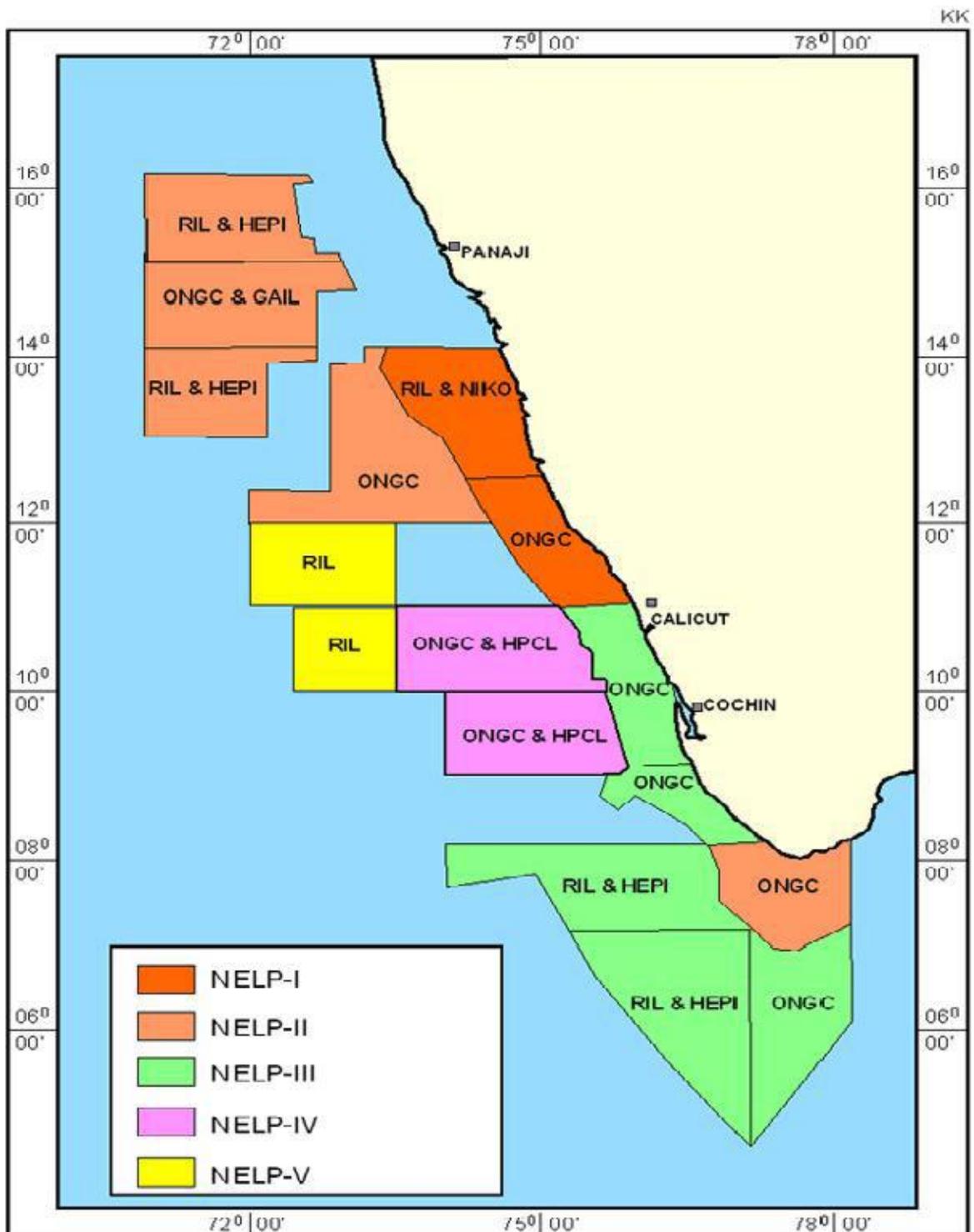
- | | | | |
|---|---|--|--|
|  | CATEGORY-I BASIN
(Proven commercial productivity) |  | CATEGORY-IV BASIN
(Potentially Prospective) |
|  | CATEGORY-II BASIN
(Identified prospectivity) |  | PRE-CAMBRIAN BASEMENT/
TECTONISED SEDIMENTS |
|  | CATEGORY-III BASIN
(Prospective Basins) |  | DEEP WATER AREAS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

The basin evolved through early rift and post rift phases and contains more than 5 km of Cretaceous to Recent sediments. Post-rift mature sediments with sufficient organic carbon content are present in the basin. Drilling results and adsorbed gas anomalies confirm generation of hydrocarbons in the basin. This basin covers an area of around 580,000 Sq.Km.. This basin comes under category III. There are 15 exploratory wells drilled so far but none of them are producing, but wells like Kasargod-1, KK-OS-V1-1 and CSP-1 show faint oil fluorescence.

[Blocks offered in different NELP rounds.](#)

The total number of blocks offered in different NELP rounds is 16. Blocks under operation

at present are 12. The major operators in Kerala–Konkan are Oil & Natural Gas Corporation (ONGC) and Reliance Industries Ltd (RIL).



Geophysical Surveys Carried out in Kerala–Konkan

The Geophysical Survey includes Gravity and Magnetic Surveys which covers an area of 45,000 LKM. The seismic survey includes 2D and 3D Surveys. The 2D Survey covers an

area of 146,445 LKM and 3D Survey covers an area of 9734 SKM.

ONGC acquired around 110,968 LKM of 2D and 5495 SKM of 3D Seismic data. Shell India and BHP Petroleum acquired 9,898 LKM and 2,384 LKM of 2D respectively. DGH has acquired 10,218 LKM of 2D seismic data in deep waters. Reliance Industries Ltd. has acquired 10,977 LKM of 2D and 4,239 SKM of 3D data.

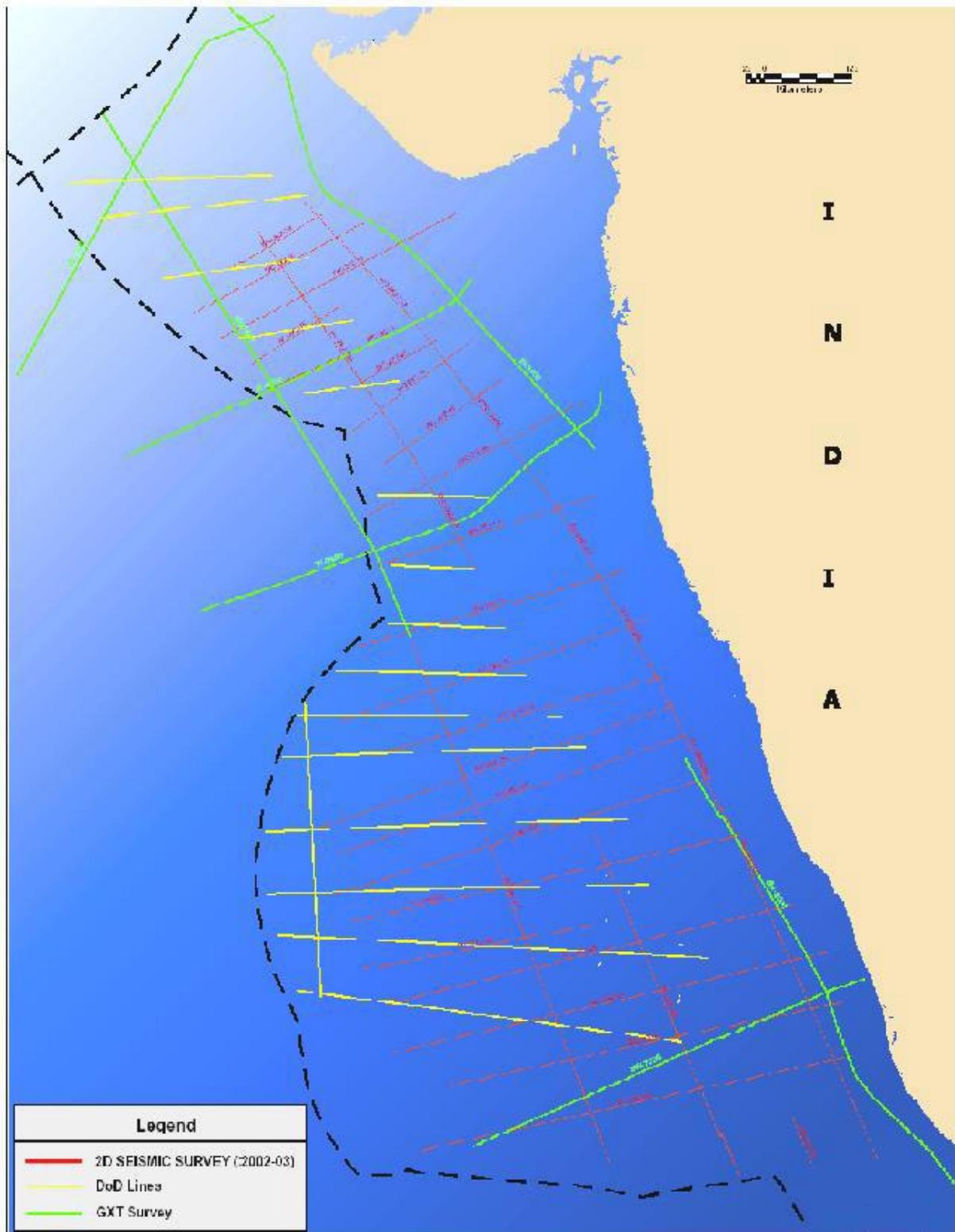
Work Carried out by ONGC & RIL under different NELP rounds.

Activities	ONGC	RIL	Total
API-2D (LKM)	9777	19935	29712
API-3D (SKM)	3653	4238	7891

ONGC committed 2D Survey of 7500 LKM and 11,800 SKM 3D Surveys for its 5 blocks in future. RIL committed 5000 LKM 2D and 7900 SKM 3D surveys for its 7 blocks in future. ONGC committed 3 exploratory wells and RIL one in future.

[2D Seismic](#)

Coverage



SI No.	Well Drilled	Operator	Drilled Depth (m)	Remarks
1	Karwar-1	ONGC	1678	Drilled upto Eocene
2	Kasargod-1	ONGC	2970	Minor Gas shows in Miocene
3	K-1-1	ONGC	1755	Encountered Basalt, drilled upto Cretaceous
4	CH-1-1	ONGC	4627	Terminated in Basalt/Trachyte section
5	CSP-1	ONGC	3833	Oil fluorescence in Eocene sands and carbonates
6	Quilon-1	ONGC	413	Abandoned prematurely
7	KK-DW-17	ONGC	2999	Drilled to Paleocene- Cretaceous
8	KK-1	ONGC	2762	Terminated in trap. Mesozoic not encountered
9	KK-DW-A-1	ONGC	4213	Only Basalt encountered from 3200m upto the bottom
10	KKD-1	ONGC		Dry
11	KK-OS-II/A-1	SHELL INDIA	2975	Encountered Basaltic flows and Late Cretaceous-Early paleocene sands
12	KK-OS-II/B-1	SHELL INDIA	2020	Gas shows in Late Miocene Claystones
13	KK-OS-V1-1	BHP PETROLEUM	3203	Terminated in Basalt section
KK-B	RIL			

Geologic History .:

The Kerala-Konkan basin situated south of east-west trending Vengurla Arch and extends upto Cape Comorin in the south of Indian sub continent in the western offshore basin. The sedimentary sequence is comprised of Mesozoic and Tertiary sediments. Western continental margin basin of India evolved through the break-up of eastern Gondwanaland from western Gondwanaland in the Late Triassic/Early Jurassic and the subsequent spreading history of the eastern Indian Ocean. The western margin evolved through early rift and post rift phases of divergent margin development. A series of regional and local horsts and grabens resulted in response to rifting along the dominant basement tectonic trends. The northernmost part of the western continental margin was the first to be subjected to continental rifting and crustal subsidence in the Late Triassic. The process of rifting gradually advanced towards south and by Cretaceous time almost all the rift-related

horsts and grabens came into existence.

The deposition started with continental environment, changed gradually to paralic and finally to pulsating marine conditions, punctuated by basic lava flows (Deccan Trap) in the terminal stages towards the end of Cretaceous and Early Paleocene. Towards the end of the early rift phase, most of the rift related grabens and horsts, located in the deeper parts were covered up with sediments and the continental margin became less intricately differentiated.

The Deccan Traps (Cretaceous – Early Paleocene) form the technical basement of the Tertiary Basin. For most part of early Tertiary period, Alleppey Plateau and Laccadive ridge were subjected to relative differential rise during entire Paleogene, thereby creating depressions around them. There were progressive transgressions, accompanied by synsedimentary positive radial movements of low to medium amplitude. Lakshadweep Depression was characterised by rejuvenation of faulting and subsidence of basement, where continental, deltaic, lagoonal and shallow marine deposition was taking place. The lithological sequence shows upward gradation from continental sand-clay section to sand-shale-coal section and finally terminating in sand-shale-coal limestone (thin) section. The depocenters kept shifting from west to east during Paleocene to Mid-Eocene period. During late Eocene-early Oligocene period finer differentiation into second order horst and graben features became more pronounced, and in some cases the direction of radial movement could have been reversed, and resulted in minor epochs of alternating transgression and regression; and consequent lateral shifting of the depocenters. Thus, the late Eocene-Early Oligocene period witnessed relative intensification of the oscillatory / pulsating movements of medium magnitude, and dominance of paralic to shallow marine depositional environment in Lakshadweep Depression.

The shelfal horst-graben complex formed the site for development of shelf depositional systems, whereas the Lakshadweep Depression and Laccadive Ridge lay in slope and basinal region. The shelf depositional systems comprised deltas, clastic and carbonate tidal flats, strandplains and carbonate ramps, platforms and banks. Lows within the shelf provided trap for the bulk of the terrigenous clastic sediments, whereas the distal and relatively positive shoal areas favoured development of thick limestone sequences.

Extensive carbonate sequences thus developed over the northern part near Vengurla arch, Alleppy platform, distal parts of paleo-shelves and around Laccadive and Maldiva group of islands Regions of favourable buildups.

Paleobathymetry over the Laccadive Ridge formed the sites for development of carbonate.

In the basin slope regions, west of the shelfal horst-graben complex, deposition of submarine fans and hemipelagic and pelagic deposits is visualised. Association of shallow and deep marine fauna in limestone bands interbedded with clastics of Early Eocene age in a few drilled wells in the Lakshadweep Depression off Mumbai suggests, that submarine canyons traversing platform limestone areas caused intermittent deposition of turbidites

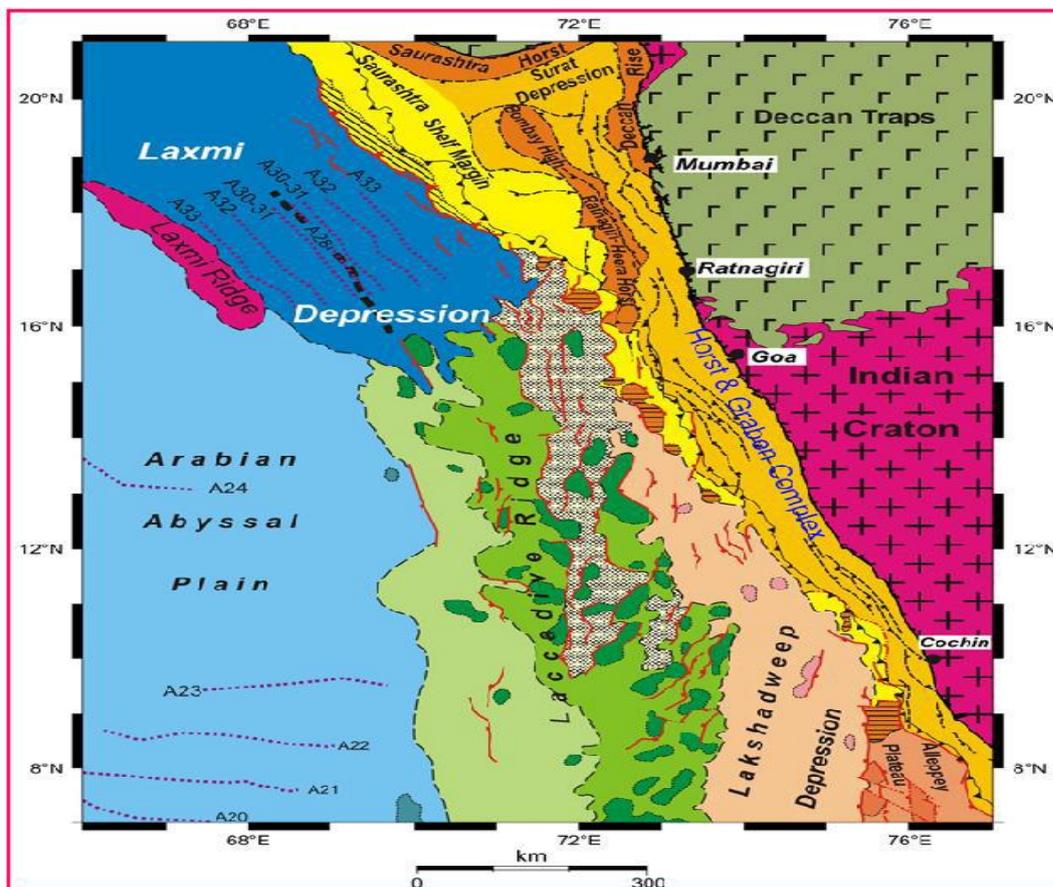
composed of allodapic limestone in basin slope transition zone.

In the post-Oligocene period, the basin acquired a marked westerly tilt, evidenced by numerous sigmoidal / progradational features observed in the Mio-Pliocene sections. Numerous channels, levees and turbidities observed on southwesterly slope have accommodated thick pile of post-Miocene sediments. A significant part of this pile is likely to belong to the Indus River fan in the major part of the Lakshadweep Depression.

Tectonic History :

Based on available G&G data, the following first order structural elements, from east to west have been identified

- i. Shelfal Horst and Graben Complex
- ii. Alleppey Plateau
- iii. Lakshadweep Depression
- iv. Laccadive Ridge
- v. Arabian Abyssal plain



Shelfal Horst and Graben complex

It constitutes the part of basin lying between the coast and 1500 m Isobaths. In the north, it merges with Mumbai shelf.

Alleppey Plateau

It is well-outlined by 200 m and 1800 m isobaths, and extends up to 2000 m down-slope. It is developed in the southern most part of the basin, South of Cochin. Morphologically it is a typical marginal plateau – a natural part of the continental margin, thrown down to deeper hypsometric level as compared to a continental shelf terrace.

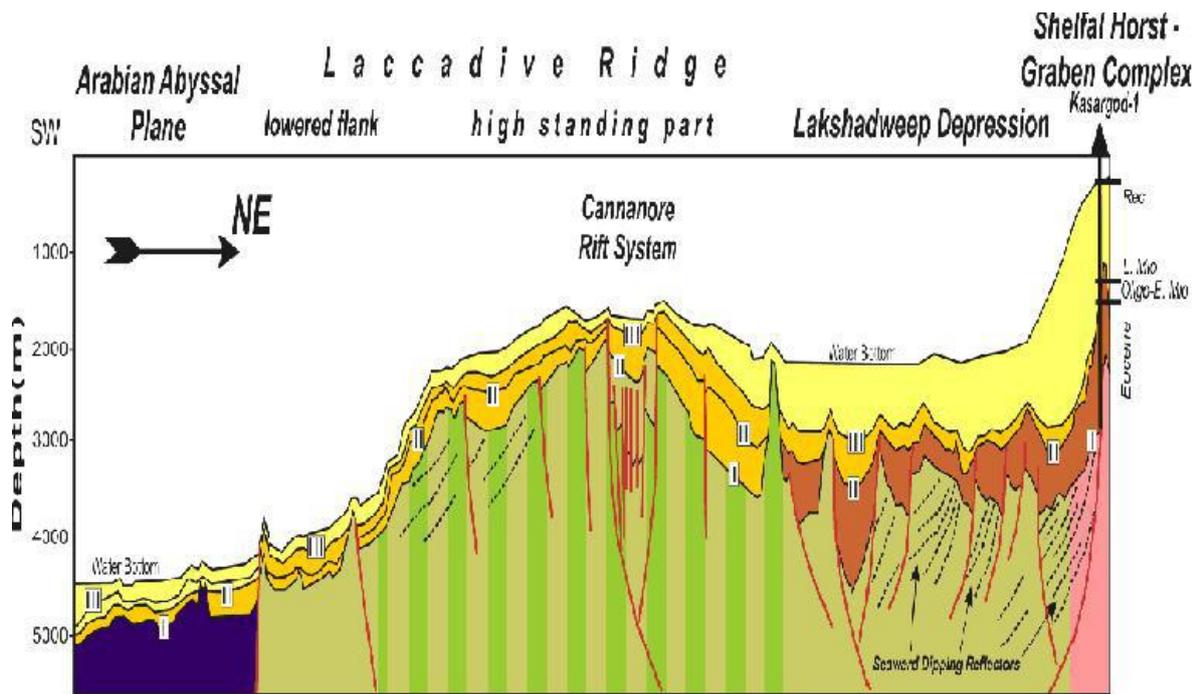
Lakshadweep Depression

It is situated between continental shelf and the Laccadive Ridge, and is almost completely outlined by 1900 m isobath. The basement of this depression is complicated by normal faulting and a series of basement tilted blocks. The width of the depression gradually decreases from approx. 215 km in the south to approx. 70–65 km in the north. The total thickness of sediments varies from 200 to 3200 m reaching a maximum about 5500 m at places. This depression displays no sign of its spreading nature and is probably underlain by a stretched continental or volcanic crust.

Laccadive Ridge

It is limited by the Arabian abyssal plain in the west and by the Lakshadweep depression in the east. Towards north, it extends upto 16° N and is limited to 6° N in the south. The ridge has a complex block-like basement structure, complicated by a system of grabens, half grabens and single normal faults, which are clearly grouped into a rift system. The latter extends along eastern part of the ridge in N–S direction from 17° to approx. 9.5° N, named as Cannanore Rift System, clearly shown by the free-air gravity field. The origin of the Laccadive Ridge has been attributed to different processes, such as a hotspot related volcanism or transform faulting and terrain tectonics. The continental origin of the Laccadive Ridge has been inferred from a few widely spaced seismic reflection and magnetic profiles. The Laccadive Ridge is considered as a continental remnant rifted away from the western continental margin of India in the same manner as suggested for the Laxmi Ridge and later reworked by the hotspot volcanism.

[Geological Section across Kerala–Konkan Basin](#)



Basement complexes

- Rifted continental crust
- Mainly volcanic pre-Santonian crust with probable relict thinned continental crust
- Mainly volcanic pre-Santonian crust with probable relict thinned continental crust modified by hotspot volcanism at Early Tertiary
- Cenozoic oceanic crust

Sedimentary cover

- Late Miocene to Recent
- Mainly Paleocene to Middle Miocene
- Mainly Late Cretaceous to Late Eocene
- Mainly Late Cretaceous

Arabian abyssal plain

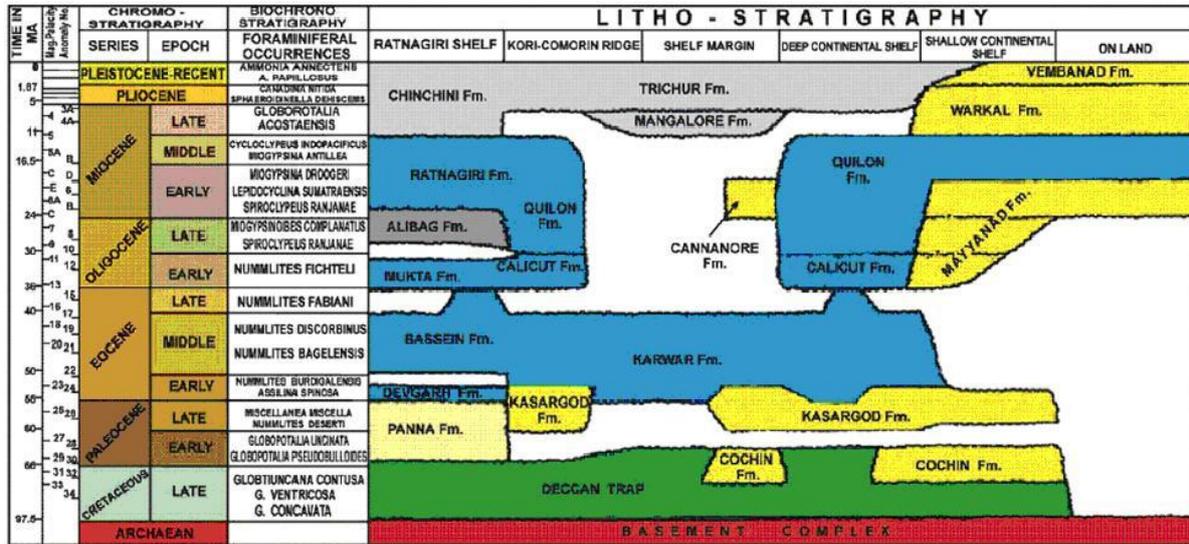
This oceanic depression, created in Cenozoic times, through the sea-floor spreading along the Carlsberg Ridge. It is consistent with a set of well-pronounced magnetic anomalies, of which the oldest anomaly A27 marks beginning of the spreading basin opening around 61 Ma.

Generalized Stratigraphy .:

Isolated exposures of Tertiary rocks are seen in the Southern and northern parts of Kerala state. All along the coastal areas scattered outcrops of younger rocks are found. In the eastern side the outcrops are limited by the exposures of Archaean schists and gneisses. Neogene and Quaternary sand, clay, lignite and limestone overlying the Archaean basement form the outcrops in the coastal belt stretching from Cochin in the north to Trivandrum in

the south.

Lithostratigraphy of Kerala-Konkan



(SOURCE : R. B. MATHUR et al., 1993)

LITHOSTRATIGRAPHY OF KERALA – KONKAN BASIN

DOMINANT LITHOLOGY	
CLAY	LIMESTONE
SHALE	DECCAN TRAP
SILTSTONE	ARCHAEN
SANDSTONE	

The rock units which are identified in Kerala-Konkan Basin are described as below:

Basement Complex

Archaean crystalline rocks of the peninsular shield composed of granites, gneisses and charnokites are exposed along the eastern margin in the Konkan and Malbar coastal areas. The outcrops are quite close to the coast near Calicut but are upto 30 to 40 Km from the coast elsewhere. The sedimentary rocks onland rest over granitic basement as seen in a few bore holes.

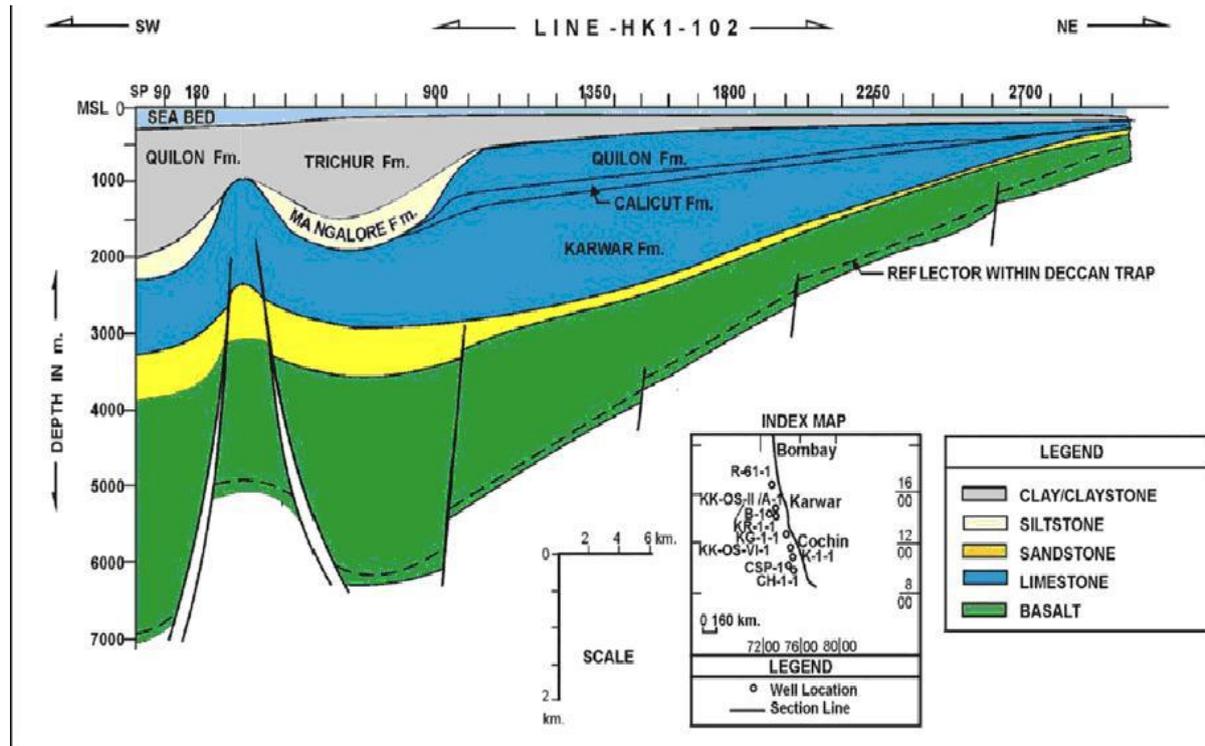
Deccan Trap

The group consists of sub-aerially effusive rocks and shallow intrusives alongwith thin clastic rocks deposited during quiescent periods at places. Lithologically it consists of dark grey to dark greenish grey, hard fractured basalts with abundant cavities with clacite & zeolite minerals. Age of this group is Late Cretaceous to Early Paleocene.

Cochin Formation

This formation is a clastic sequence deposited in continental to outer neritic environments. Lithologically it consists of sandstones, siltstones, shales and claystones. This formation is about 919 m thick and the age has been assigned an age of Late Cretaceous to Early Paleocene.

Geological Cross Section Across Central part of Kerala-Konkan Basin



Kasargod formation

This formation is unconformably overlying Cochin formation. This formation consists of argillaceous limestones in the lower part and sandstones and shales in the upper part. This Formation is represented by fresh water sediments on the shallow shelf and by marginal marine and shallow inner neritic deposits on the deeper continental shelf. The formation has been assigned an age of Early Paleocene to Early Eocene.

Karwar Formation

Lithologically this formation consists of carbonate facies comprising grey, light grey and brownish grey limestone with occasional thin shale bands. Environments varying from lagoonal and restricted marginal marine towards basin margin to inner neritic in deeper parts prevailed during the deposition of the formation. Age of this formation has been assigned as Early to Middle Eocene.

Calicut formation

This formation has been recognised to include limestones sandwiched between the Eocene and the Early Oligocene unconformities. The sediments were deposited under open marine inner neritic to shallow shelf and marginal marine environments. Early Oligocene age has been assigned to the formation.

Mayyanad Formation

The formation comprises coarse to medium grained sandstones with interbedded white and grey clays and lignites in the coastal area of Kerala. The age of this formation is ranges from Early Oligocene to Early Miocene. The sediments were deposited under shallow fluctuating marginal marine and swampy environments.

Quilon Formation

Lithologically this formation comprises of brownish white to dirty white, buff and grey foram algal wackestones and packstones, which are dolomites in several intervals. The formation was deposited in very shallow marine to inner neritic environments. Late Oligocene to Middle Miocene age has been assigned to the formation on faunal evidence.

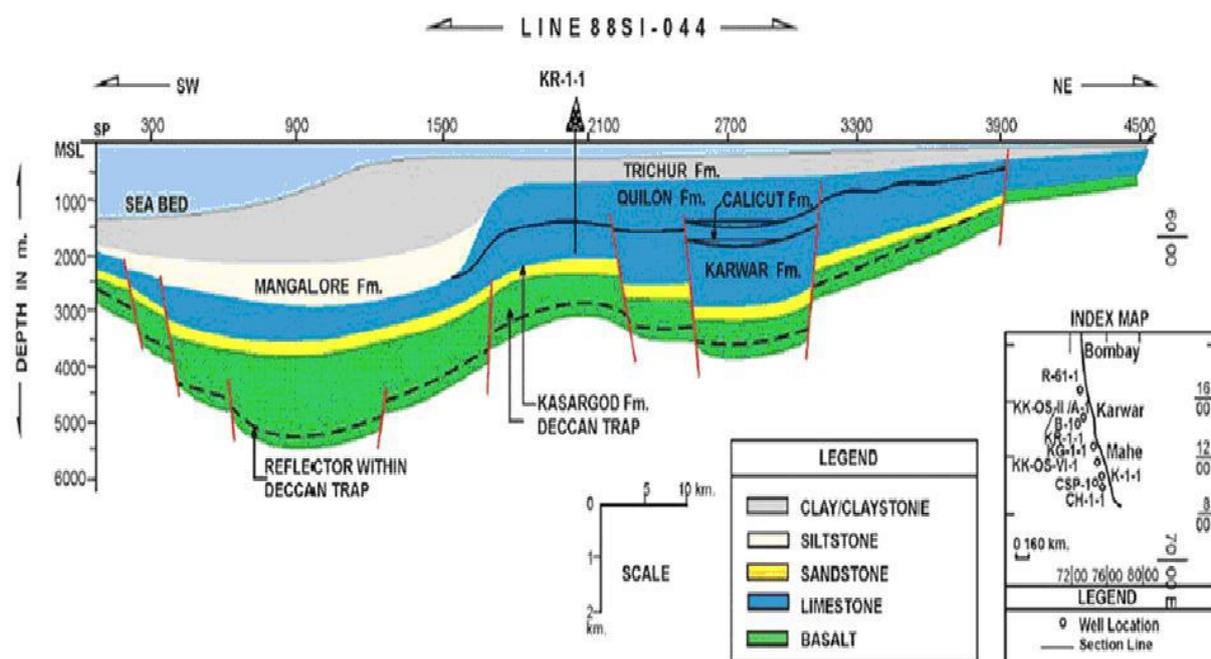
Cannanore Formation

This formation comprises of a sequence of shales and sandstones with a few thin limestones. The depositional environment of this formation is a fluctuating environment between middle neritic and upper bathyl regimes. Early Miocene age is assigned to this formation.

Warkali Formation

It is a sequence of grey pebbly and coarse sands variegated and mottled clays, white plastic clays and peat/lignite. The formation was deposited under extremely shallow marginal marine environment. Late Miocene to Pliocene has been assigned as the age of this formation.

[Geological Cross Section Across Northern Part of Kerala-Konkan Basin](#)



Mangalore Formation

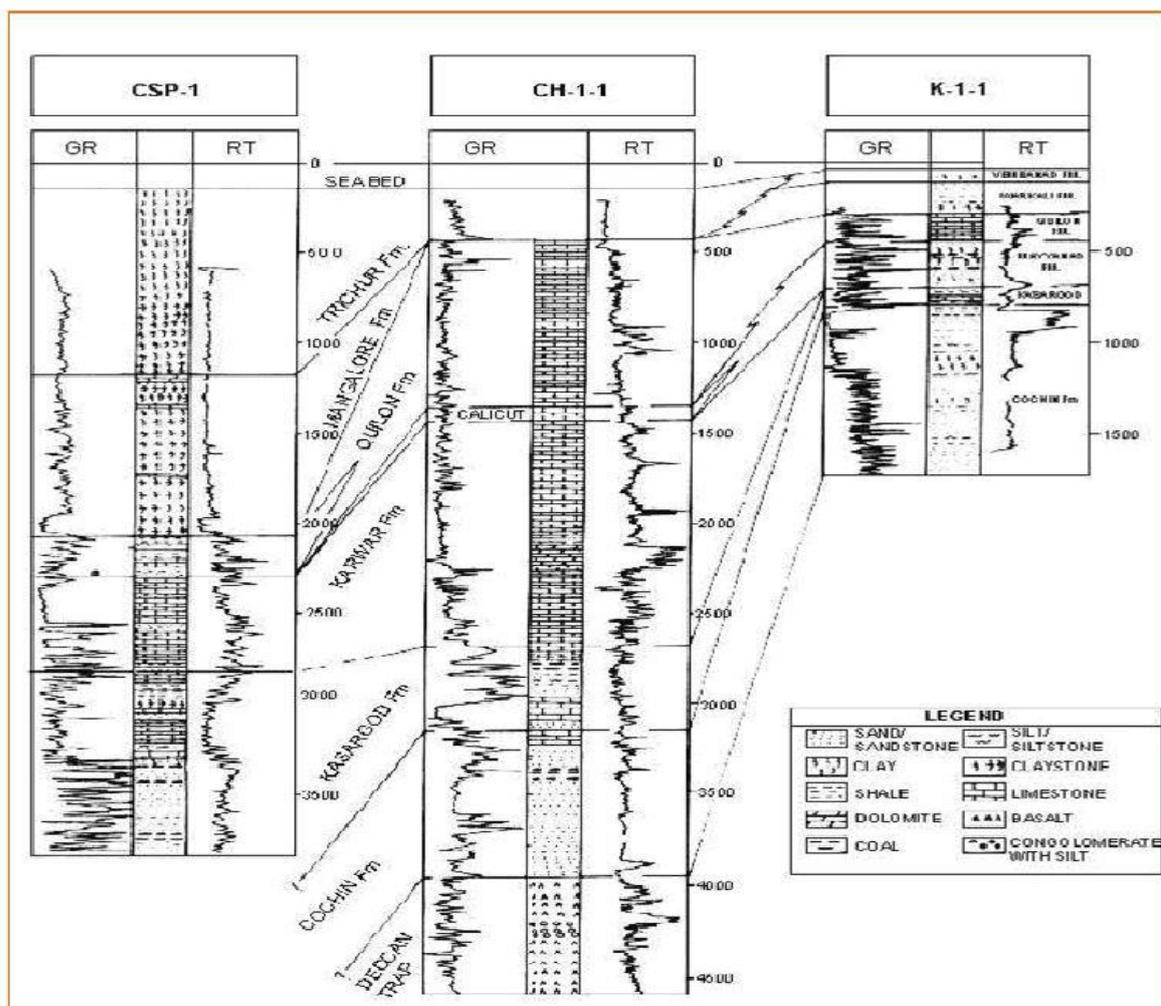
It comprises a sequence of claystones and shales. The age of this formation is assigned as Late Miocene.

Trichur Formation

It comprises a sequence of light to dark grey and brownish grey, soft, sticky plastic clays and claystones with abundant shell fragments and occasional thin limestone, dolomite or siltstone bands. The formation was deposited under middle to outer neritic environment and has been assigned an age of Late Miocene to Pliocene.

Vembanad Formation

This formation comprises sands, peat, black, sticky and sandy calcareous clays, gravel beds with lateritic gravels, lime shell deposits and alluvium in Kerala coastal region. Pleistocene to Recent age is assigned to this formation.

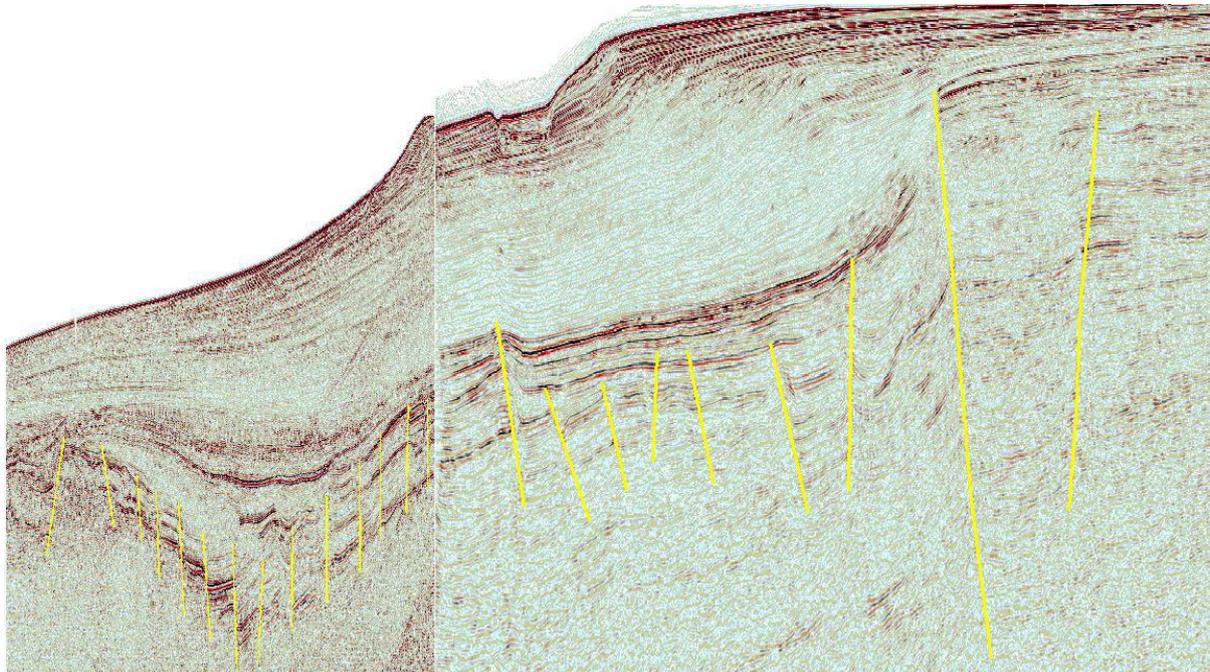


Petroleum System :

Source Rock

The source rock is mainly Paleocene to Eocene shales .The Karwar Formation (Eocene) has rich organic matter (TOC upto 29%) and Kasargod Formation (Late Paleocene) has fair to good source potential . Paleocene to Middle Eocene shales, have fairly high TOC content mainly of type II and III organic matter, and are thermally mature. Shelfal Depressions & Lakshadweep Depression are considered to be kitchens for hydrocarbon generation.

[Exploration from Shelf Wells indicates Analogous possible Kitchen areas in Deep Water blocks.](#)



Reservoir Rock

Eocene to Middle-Miocene Carbonates & Paleocene to Middle Miocene Sandstones are the possible reservoirs of Kerala-Konkan. Extensive carbonate platforms and shelf margin reefal bodies developed during Eocene to early Middle Miocene post rift phase over almost the entire western part of the shelfal horst-graben complex which serve as the reservoirs. The slope basin transition zone, particularly in front of the major shelfal depressions, is favorable for development of turbidite reservoirs in deep-sea fan complexes. There is a possibility of extension of turbidite reservoir facies locally into the Laccadive Depression through submarine canyons. Carbonate platforms around Laccadive Islands are likely to provide abundant reservoir bodies in the region of Laccadive Ridge

Cap Rock

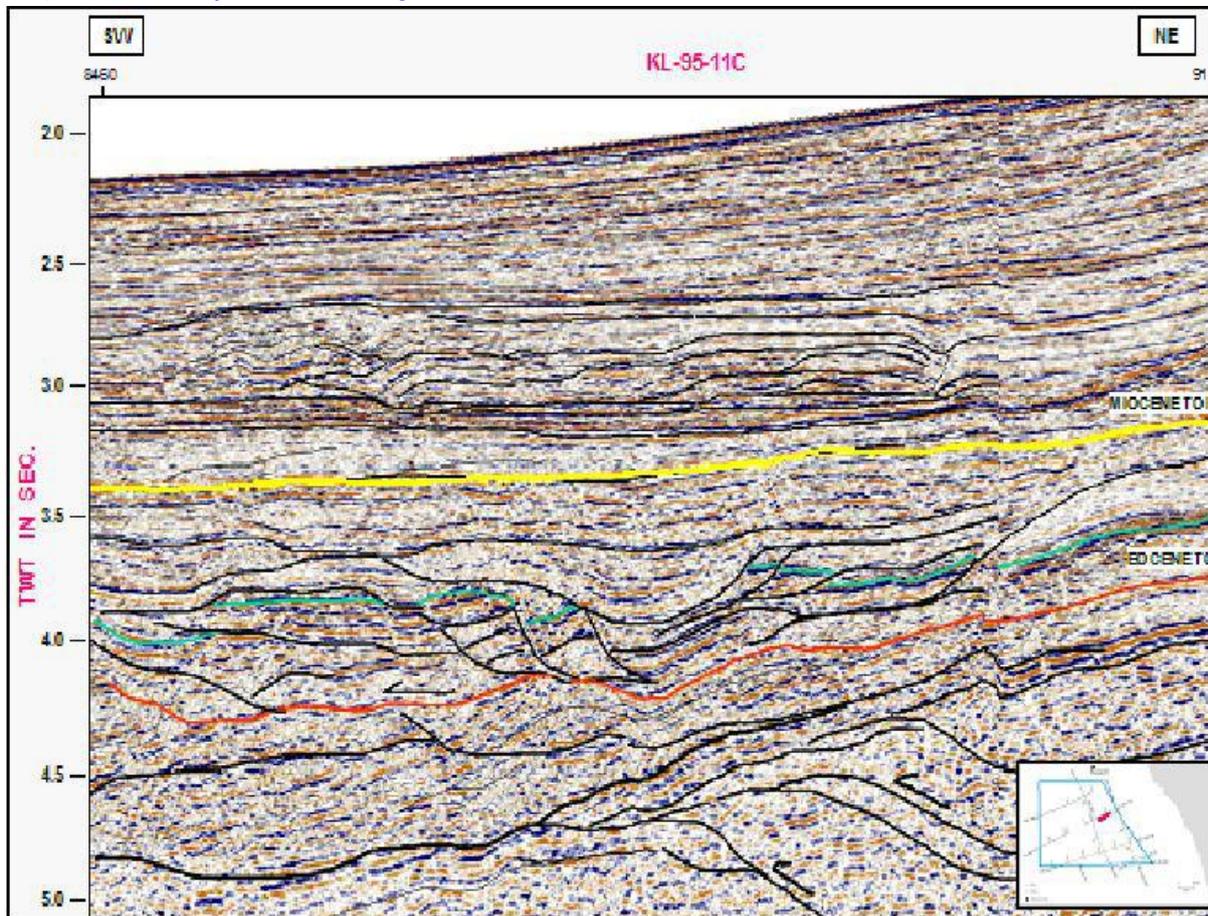
Eocene to Middle Miocene Limestone Bands serve as the cap rock in this basin.

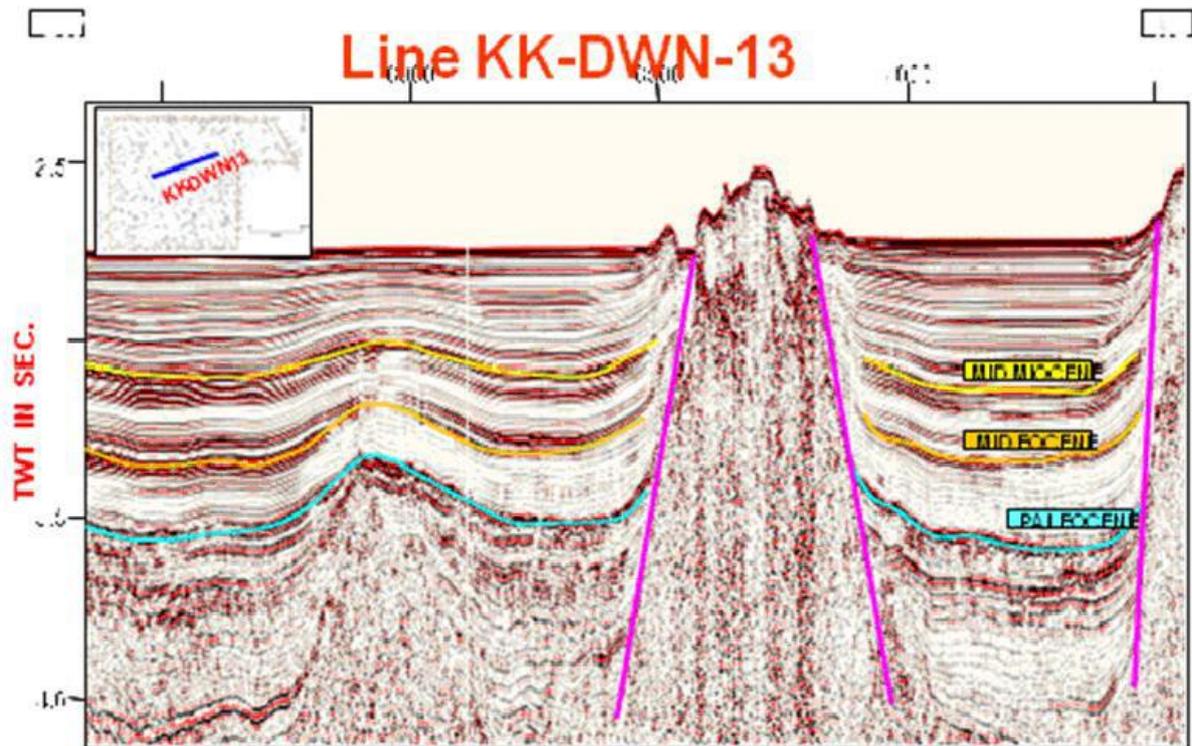
Petroleum Plays :

Play Types

The accumulations are mostly related to horst blocks, shale tectonics, normal anticlines, and strati-structural unconformity controlled entrapments. Basement highs in the shelf margin are the sites of carbonate buildup at several places. Pinchouts of Paleogene sequence and Wedgeouts against Vengurla arch are also acting as trap.

[Traps Formed by Cross cutting Slides](#)





Hydrocarbon Potential

The depositional models of the initial post-rift and late post-rift phases of basin evolution, suggest that Kerala-Konkan Basin holds promise for hydrocarbons. The prognosticated resources of Kerala-Konkan offshore basin are estimated to be 660 MMt.

Challenges & Scopes :

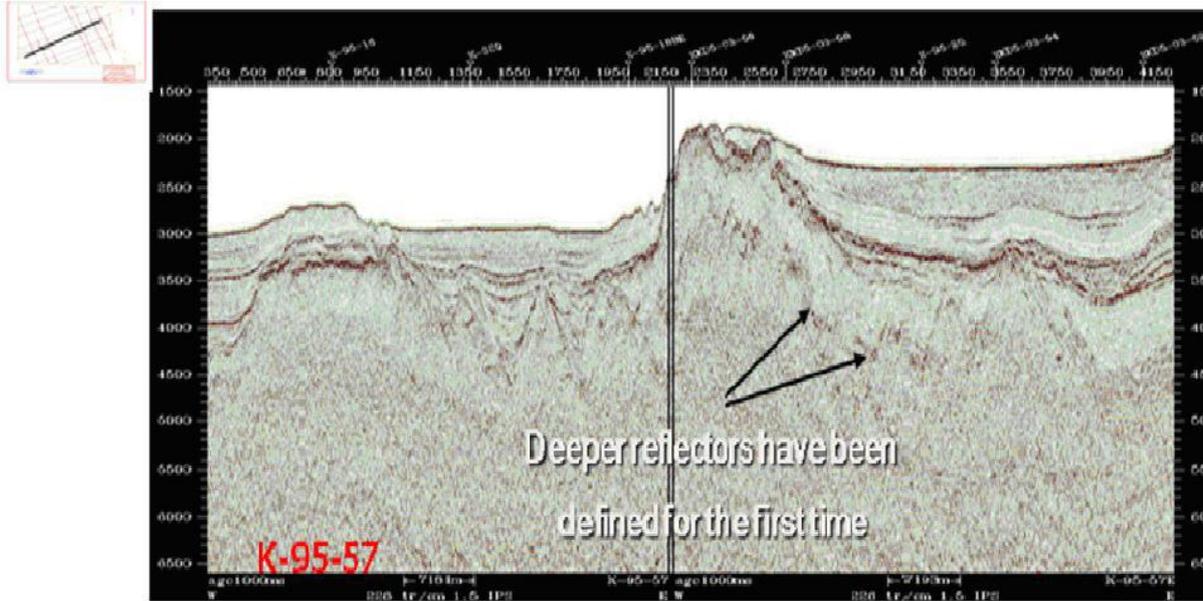
Hydrocarbon has been discovered all through coastal areas of India except Kerala-Konkan basin. In Kerala-Konkan the Tertiary and Mesozoic sediments are separated by a thick Basaltic layer. Imaging below basalts has always been a problem in oil exploration. The thick basalt is opaque and masks deeper seismic events below the basalt. Only few wells have penetrated and drilled below the basalt. Till date the petroleum system has not been established in this basin. Moreover the establishment of the hydrocarbon kitchen area, migration path and entrapment has to be established. Wells drilled in Kerala-Konkan has shown the presence of hydrocarbons while drilling but production testing results not encouraging this fact.

The structural style of Kerala-Konkan Basin is similar to Bombay Offshore Basin. However the horst and graben features on continental shelf are comparatively less pronounced area. Mainly we need to shift focus towards the Mesozoic exploration. Long offset data has yielded better sub-surface images below the trap which has been masked earlier; has brought out more sedimentary thickness. Heat flow studies done in few blocks have yielded

better results. Multibeam survey, done in few RIL blocks, have given the direct indication of Hydrocarbons, has to be extended to other blocks also. Sea bed logging survey has given indication of Hydrocarbons, has to extend regionally.

Reprocessing of data gives better resolution which helps in identifying interesting structures which may miss earlier.

[Better Resolution of deeper Reflectors after Reprocessing.](#)



In brief Kerala-Konkan is a rare opportunity and turning it into a proven value accretion necessitates an exploration paradigm shift in terms of concepts, technology and personnel expertise.