An Integrated Evaluation of Geoscientific Data to bring out Hydrocarbon Entrapment Model of South Nagapattinam Subbasin, Cauvery Basin, India

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The objective of this study was to identify and analyse the depositional model of passive margin Upper Cretaceous, to understand the Petroleum system, and to decipher the Paleotectonic evolution and identification of exploration targets of South Nagapattinam subbasin of Cauvery Basin, India. Eastern boundary of Indian plate was rifted from Gondwanaland during Albian time. In the south Nagapattinam area of Cauvery Basin, two roughly North – South trending, easterly hading extensional fault systems are identified. Extensional voids thus created were compensated by north-south trending westerly hading accommodation faults. Late and post Cretaceous tectonics created some east – west trending fault systems. An easterly to south-easterly slope was created due to these extensional fault systems. In this set up, early syndrift sequences of Turonian and Cenomanian age were deposited. In the southern part of the stemmed fault systems, the deposition was mainly dominated by short spanning non-Newtonian flow, resulting in poor reservoir facies. Northern spread apart fault systems supported longish Newtonian flow systems, resulting in well sorted submarine fan and channel fill deposits. End of sequence Turonian trigerred by fresh tectonics, resulting in reactivation of many faults in the study area. The next sequence of Coniacian to Lower Campanian age was however deposited in an overall trangressive regime. End of the Lower Campanian was triggered by fresh bout of tectonics and creation of new accommodation spaces. Subsequent depositional mechanism was probably stacked channel systems, in shallow marine environments. Thus attained near peneplanation was however a short lived one, being disturbed by fresh tectonics at the end of sequence K3R, creating a major unconformity at the end of Cretaceous.

Shelf Delta to Deep Water Basin; A Depositional Model for Krishna-Godavari Basin

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Krishna-Godavari basin is located on east coast of India is a passive margin setup with a lateral stretch of about 500 km and extends more than 200 km from the coast into the deep sea. This basin has been fed dominantly by Krishna and Godavari river systems along with numerous tributaries. The basin represents a complete depositional setting with well defined shelf to shelf edge delta to deepwater. The area is adequately covered by several vintages of 2D and focused 3D seismic data which has been primarily used for subsurface imaging. Further the depositional units have been identified by interpreting seismic stratal pattern and the facies distribution in a sequence stratigraphic framework. This is supplemented by information from wireline logs and cores. The gradational facies pattern, sequence boundary, transgressive surface, maximum flooding surface, channel architecture etc. have been demonstrated in selected seismic sections for developing the concept. The study is not only useful in understanding the depositional processes in shelf-shelf edge-deep water and their linkages but also a good guide for the deepwater hydrocarbon exploration targets.

Indian East-Coast Basins and Hydrocarbon Play Types

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The East Coast of India has been categorized into seven different basins from north to south. Recognition of these individual basins is based on major tectonic trends and sediment fill types that can be deciphered from gravity-magnetic patterns and seismic imaging. Genetically the East Coast of India represents an Atlantic type passive margin setup that has been evolved through a multiple rift-drift cycles (RD-Cycle).

The rift phases and syn-tectonic sequences have been identified from global plate reconstructions with special reference to East Coast of India. In some cases rift-branches are subdivided into rift zones in ways that are morphologically obvious but mechanically not clear. Usually the zonal boundaries coincide with a pattern expressed in the form of offsets, kinks or major changes in the trends of adjacent rift zones. Phases of rift activity are thus treated as recognizable structural units with well-defined vertical and areal boundaries.

An attempt has also been made to distinguish the hydrocarbon system and play types for both rift related and other structural styles using high quality 2D and 3D seismic imaging information. Rift sequences corresponding to pre, syn and post-rift fills have been identified with the mappable events. Structural mapping of half-grabens also reveals cross trends that may control depositional patterns.

Himalayan Frontal Fold-Thrust Belt, NW India: Geometry, Structural Evolution and Hydrocarbon Prospects

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The Himalayan frontal fold-thrust belt (FTB) is one of the longest FTBs in the world. Several oil/gas fields have been discovered during the last 125 years in the Himalayan FTB in Pakistan and Assam-Arakan FTB in northeastern India. However, no commercial oil/gas discovery has taken place in the intervening areas in India, Nepal and Bhutan although many oil and gas seeps are known from this area since historical times. We have constructed five serial balanced cross sections in the northwestern Himalayan FTB, using surface geological data and well data. Departing from usual practice, we restore deformed-state cross sections in discrete steps; at each step we restore only one fault and ensure that the section remains admissible and viable at every step of restoration. This allowed us to work out the admissible geometry, sequence of thrust development and also estimate slip on each fault at each stage of fault development. Variation in structural geometry of the FTB can be segmented into three longitudinal zones. In the frontal zone towards the foreland, structural geometries are simple with widely spaced ramps and related folds. The structural geometries become relatively more complex in the middle part of the FTB with low ramp spacing, interference of axial surfaces and folded thrusts. A number of horses dominate towards the hinterland. The structural evolution can be best described in terms of forward-breaking in-sequence thrusting, followed by out-of-sequence thrusting in an approximately break-back style. In an area with such structural complexity, a thorough understanding of subsurface structural geometry is essential for hydrocarbon

exploration. Based on our sections, a number of play-types have been identified, where detailed exploration for hydrocarbons may be taken up.

Integrated Formation Evaluation of a Deepwater Exploration Well in the East Coast of India

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Deepwater environment in India presents a unique challenge to formation evaluation. The reservoirs encountered are of complex lithology consisting of feldspathic sands, authegenic clays and heavy minerals. Also, the formations are often unconsolidated. This coupled with the presence of highly conductive clays and thin beds, each having a significant effect both on porosity and resistivity measurements, makes it difficult to rigorously evaluate the formations volumetrically. This paper presents a case study from an Indian deepwater exploration well where the basic measurements combined with nuclear magnetic resonance, elemental spectroscopy, natural gamma ray spectroscopy and dipole sonic have been used to resolve issues such as complex lithology, low-resistivity pay, thin-bed analysis, and gas effect on porosity. Combining the elemental spectroscopy and natural gamma ray spectroscopy measurements to solve for the solids, i.e., determining the volume of clay from the elemental spectroscopy and then splitting it into various clays based upon the natural gamma ray spectroscopy, helped us resolve the complex lithology. The porous space was evaluated by the NMR measurement, which is lithology independent. The fluid encountered was gas; it's effect was handled by combining NMR with density and sonic measurements. NMR fluid identification stations were also used for gas detection and flushed-zone gas saturation determination. Moreover, microresistivity borehole images and high-resolution NMR logs were integrated for permeability evaluation over thin-bedded sections. The results from this integrated formation evaluation assisted in optimizing the logging program in the next deepwater well and reduce log acquisition time by 24 hrs.