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Depositional system of Nannilam play in Ariyalur-Pondicherry and Tranquebar sub basin area of Cauvery Basin

ABSTRACT

The objective of this study is to bring out a geological model for depositional system of Nannilam play in Ariyalur-Pondicherry and Tranquebar sub basin area. Commercial oil and gas production from Nannilam play is established in the Neyveli field of Ariyalur-Pondicherry sub basin, PY-3 of Tranquebar sub basin offshore part, and Mattur, Nannilam, Tiruvarur fields of Nagapattinam sub basin. It has given impetus to establish a similar play in the study area. Nannilam sediments are unconformably underlain by Turonian sediments and overlain by Paleocene sediments. The Depositional system is explained through electrolog correlation, seismic interpretation, paleo position of coast, shelf edge, fossil occurrence and sea level fluctuation curve. Based on the studies it is inferred that Nannilam sediments were deposited under inner-outer neritic regime in the form of fan delta, slope fan complex in the western margin of Tranquebar and Ariyalur-Pondicherry sub basin area. In the offshore part of Ariyalur-Pondicherry and Tranquebar sub basin area, sands were deposited as a basin floor fan complex in deep marine condition by gravity driven process. These features are the target areas for Nannilam sand exploration and exploitation.

Key Words: Nannilam Formation, Ariyalur-Pondicherry sub basin, Tranquebar sub basin.

Introduction

Cauvery basin is a peri-cratonic rift-drift basin, which came into existence as a result of the breakup of Gondwanaland. Cauvery basin further disintegrated into NE-SW oriented horst and graben structures divided into six sub basins. The study area covers the northern part of Cauvery basin, which consists of Ariyalur-Pondicherry sub basin, Kumbakonam-Madanam high, and Tranquebar sub basin (Fig-1&1a) and constitutes sediments ranging from Mid-Jurassic to Recent (Fig-2). Nannilam play of Upper Cretaceous age is a prolific producer in Nagapattinam and Ramnad sub basins and shallow offshore area of Tranquebar sub basin. Though, this play is established only in Neyveli area of Ariyalur-Pondicherry and PY area of Tranquebar sub basin but the potential of vast area left out is to be established. Therefore, the present study is focussed to identify prospective areas for exploration and exploitation of Nannilam sand by better understanding of depositional system of Nannilam play. As on date around 115 wells were drilled in the study area, out of which 39 wells were drilled with Nannilam formation as primary/ secondary target. Porosity value of Nannilam sands in the range of 10-15% in the western margin of Ariyalur-Pondicherry sub basin, Kumbakonam-Madanam high and its flank

areas. Towards the east in the deeper part of the basin porosity ranges from 5-8% that indicates poor reservoir facies.

Geological settings and Stratigraphy of Ariyalur-Pondicherry and Tranquebar sub basin.

Stratigraphic record of Cauvery basin shows that the preserved sediments are, ranging in age from Middle Jurassic to Recent. The present study is restricted to upper Cretaceous sediments of Coniacian-Santonian and Campanian-Maastrichtian periods. The sediments deposited during these periods are classified as Nannilam Formation. Nannilam sediments are unconformably underlain by Turonian sediments and overlain by Paleocene sediments (Fig-2). Upper Cretaceous sediments are represented by a post-rift depositional unit. The late Turonian-Coniacian regression has resulted in deposition of sands in the western margin slope area of Ariyalur-Pondicherry sub basin in the form of slope fans. The relative rise of sea level during Coniacian–Santonian period brought more areas under marine environment and submerged most of the highs that resulted in deposition of thick shale in Ariyalur-Pondicherry and Tranquebar sub basin area. Followed by Santonian transgression, the basin had witnessed minor regression during Santonian-Campanian period, which resulted in lots of coarser clastic inputs from proto Cauvery River that formed a major fan delta complex in western margin of Tranquebar sub basin and led to the formation of isolated slope fans in Ariyalur-Pondicherry sub basin area. During the same period, the sediments deposited in Tanjore sub basin area was eroded, reworked and transported by gravity driven process and formed a huge basin floor fan complex in the Tranquebar and Ariyalur-Pondicherry offshore area.

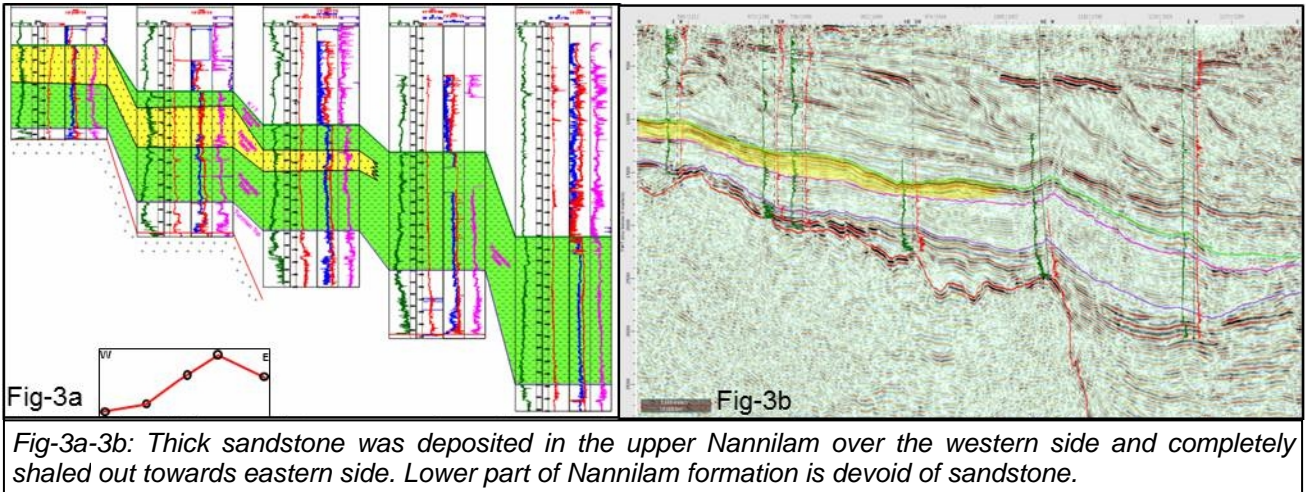
Methodology of study

Detailed electrolog correlations were drawn with marking of sand tops and bottom for the entire study area through different profiles. Sand model and Gross Depositional Environment model for Nannilam formation were prepared. Based on the understanding of depositional environment, reservoir and non-reservoir facies were identified.

Analysis of Litho-facies variations through Electro log correlation

A detailed electrolog correlation profiles were generated to analyse the litho-facies variation along dip and strike direction. Sands encountered within Nannilam formation in each wells had been identified from the electrologs and lithological data. Sand top and bottom had marked mainly based on

consistent log signatures observed in gamma ray and neutron & density curves and well wise sand thickness was determined. Sand thickness values were plotted on the base map and prepared sand isolith map. Electrolog analysis shows that presence of sands with porosity ranging from 10-15% and minor shale in the upper part and thick shale in the lower part of Nannilam formation deposited in the Tranquebar sub basin. In the Ariyalur-Pondicherry onland and offshore part & offshore part of Tranquebar sub basin sands with porosity ranging from 15-20% deposited both in upper and lower part of Nannilam and thick shales deposited in the deeper part of the sub basin towards the east. (Fig-3a-3b, 4a-4b, 5a-5b, 6a-6b & 7a-7b).



Sand model and Sand Isolith Map

Nannilam sand model was conceptualised after analysing all the available well data, electrolog correlation and position of the paleo coast and paleo shelf edge (K.G.Vijayalakshmi and R.Kalyanasundar). During late Turonian-early Coniacian regression period, sands were mainly deposited in the shelf-slope area of the western margin of Ariyalur-Pondichery sub basin. Based on the biostratigraphy study in the western margin wells, fossil assemblages (Bolivinoides sp, Gyroidinoides, Alabamina sp) suggested that Nannilam sediments were deposited in Middle-outer neritic environment. During Coniacian-Santonian transgression huge thickness of shale got deposited in the basinal part and this shale is interpreted as non-reservoir finer clastics which got settled in the distal part of the fan. During Late Santonian-Early Campanian, basin witnessed minor regression that

resulted enormous deposition of sand in the shelf area in the western margin of Tranquebar sub basin which is modelled as a fan delta complex. During the same period the western margin area of Ariyalur-Pondicherry sub basin witnessed deposition of a discrete sand body in the slope area and is modelled as slope fan complex. Fossil occurrence (*Globotruncana rosetta*, *Lenticulina*, *Textularia*) observed in the northern part of the sub basin indicates outer shelf-upper bathyal environment of deposition. Hence, it is modelled as minor independent slope fans. The sand body deposited in Tranquebar and Ariyalur- Pondicherry offshore area during the early Coniacian and late Santonian regression is modelled as a basin floor fan complex by envisaging sand inputs from Tanjore sub basin area. Sand thickness/ isolith map shows that the thickness of sand gradually decreases towards the deeper parts of the sub basin in the east (Fig-8).

Gross depositional environment (GDE)

Gross depositional environment (GDE) of Nannilam formation has been deciphered by integrating electrolog interpretation, Biostratigraphy, sand model, and Paleogeography of Santonian and Maastrichtian period (Paleogeography Maps of Cauvery Basin by Dr. B.C.JAIPRAKASH and etl, RGL, Chennai). (Fig-9a-9b).

After incorporating all the data it is inferred that the depositional environment during late Turonian-Early Coniacian was in the middle to outer neritic regime of the shelf edge-slope set up. It was

observed that no coarser clastic was deposited during the same period in western margin of Tranquebar sub basin. During Santonian transgression huge thickness of finer clastics were deposited under bathyal-abyssal environment. Similarly Late Santonian-Early Campanian regression in the Tranquebar sub basin western margin witnessed delta building activities under inner-middle neritic regime and during the same period sands were deposited in the middle-outer neritic regime under slope environment in the western margin area of Ariyalur-Pondicherry sub basin. The shallow offshore part of Ariyalur-Pondicherry and Tranquebar sub basin is inferred as the reworked sediments were deposited under abyssal setup as basin floor fans. In the basinal part of Ariyalur-Pondicherry and Tranquebar sub basin area, depositional set up was interpreted as deep marine condition during the entire period of upper Cretaceous where huge pile of shale got deposited (Fig-10).

Conclusion

From the studies it has been inferred that, the sand bodies deposited as basin floor fans in the lower bathyal regime of Ariyalur-Pondicherry and Tranquebar sub basin are better target area for Nannilam sand exploration due to the presence of better reservoir and source facies. Sands deposited under shelf-slope system as fan delta and slope fan complex in the western margin area are also exploration targets for Nannilam sand. Absence of reservoir facies is observed in the upper-middle bathyal environment in the basinal part.

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