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Hydrocarbon habitat of the Cauvery Basin, East coast of India

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Source rock identification is a significant aspect in evaluating a petroliferous basin. The present study provides a regional evaluation of the source rock potential and maturation history of the Mesozoic successions in the offshore Cauvery blocks. The sediments from the Mesozoic sections of varoius wells were studied and they possibly represent the major potential petroleum source rocks in the region. The two prominent organic matter rich horizons are in the Campanian and the Early Cretaceous sediments. Anoxic event relates source rocks have not been considered in this study. In order to understand the reason behind the abnormally high TOC in Campanian without any anoxic event, a detailed correlation of TOC with sedimentary facies was attempted. It is observed that the units having higher sand content coincides with higher TOC intervals. These Campanian sediments which are composed of terrestrial plants are transported and deposited by turbidity currents/gravity flows in the deep water system. The elevated organic matter content in turbiditic sandstone of the Campanian is similar to the high organic content found in turbiditic sandstone of the Kutie basin, Indonesia where under suitable maturity, the same turbiditic sandstone act as a source and reservoir holding more than 6 tcf of gas and 200 million bbl of oil and condensate (Saller et. Al, 2006). The Early Cretaceous sediments have moderate to good preserved source rock interval and have dominantly Type III organo facies with contribution of Type I organic matter while the Campanian section is dominanted by Type III organo facies with minor contribution of Type II. The Campanian section has Rock-Eval Tmax values below 430°C which suggests that the source rock is thermally immature, the Early Cretaceous section recorded a Tmax ranging from 415 °C to 479 °C and is consistent with vitrinite reflectance values, suggesting the presence of early to late mature kerogen.

Introduction

The present study provides a regional evaluation of the source rock potential and maturation history of the Mesozoic successions in the Cauvery blocks of RIL. The sediments from the Mesozoic sections were studied and they possibly represent the major potential petroleum source rocks in the region. Determining the type, quantity, distribution and the degree of thermal maturation of organic matter in time and space are critical parameters in understanding the source-rock potential in a basin. The above mentioned parameters is a function of many factors, the most important being the paleogeography of the basin, climate, terrestrial organic productivity, lacustrine/marine aquatic organic productivity, oceanic circulation, sedimentation rate and water depth (Emery and Myers, 1996).

An integrated interdisciplinary assessment using Geochemistry, Biostratigraphy and Sedimentology has been attempted to evaluate these source rocks.

Materials and Methods

In order to predict the pod of petroleum source rock, the source rock thickness and organic richness in seven drilled wells (Fig.1) of the Cauvery basin were studied using basic source-rock screening analyses such as %TOC and Rock-Eval pyrolysis. The organic carbon content was determined by combustion of the sample in Leco WR 112 Carbon Analyser. The Rock-Eval 6 Analyser was used to evaluate the thermal evolution of organic matter. The rock eval pyrolysis was done for samples with TOC (Wt %) more than 1. Visual Kerogen analysis was carried out in one well.

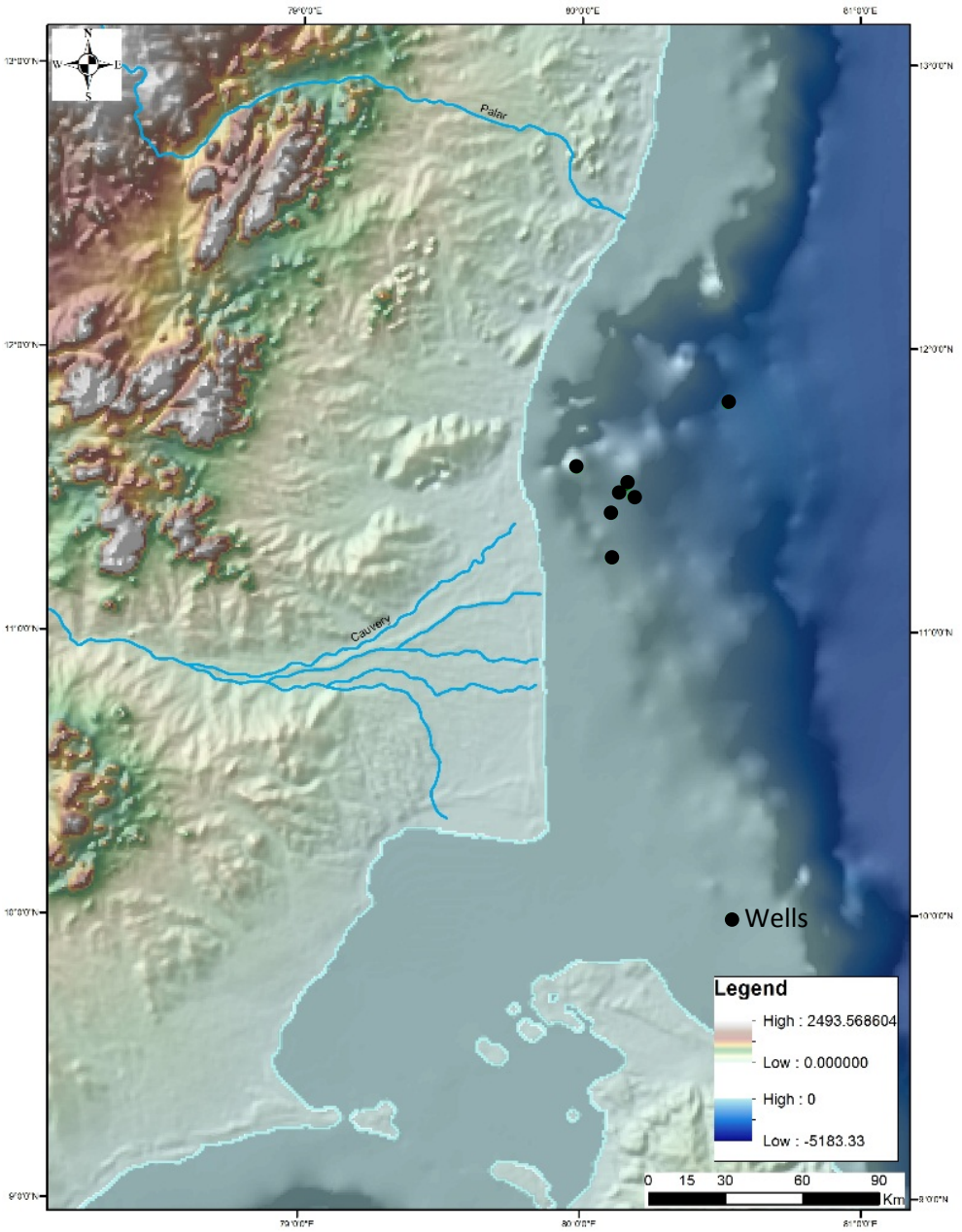

Fig 1: Location map of wells used in the study

Results and Discussions

Postrift Source Rocks

All the 7 drilled wells have penetrated the postrift Cretaceous section. The earliest post rift section is encountered in two wells and they show very low TOC of less than 0.5%. However anoxic events have been identified in one well using biostratigraphic data. Abrupt increase in planktonic: benthonic ratio and reduction in benthonic diversity are used to demarcate anoxic related events (Fig 2). It is not associated with high organic matter content as preburial alteration (oxidation) could have decreased contribution of terrestrial organic matter and similar phenomenon has been reported from onland wells (Chandra et.al, 1999). However organic matter enrichment during the Albian -Aptian times cannot be ruled out as it depends mainly on the structural locales, organic matter production and preservation.

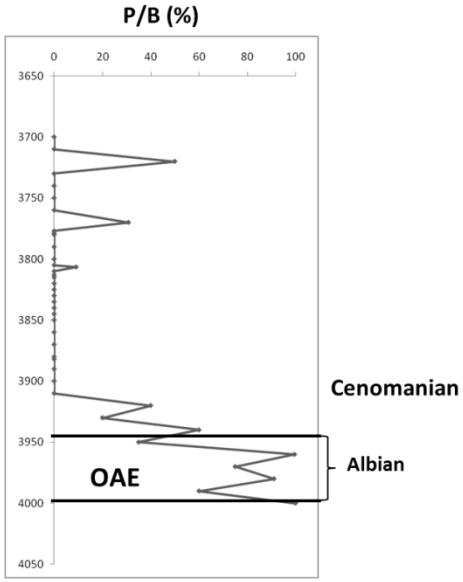

Fig 2: Planktonic-benthonic ratio showing the position of Albian-Cenomanian OAE

In the upper Cretaceous section, Campanian is the only interval which has good TOC with moderate HI values. In order to understand the reason behind the abnormally high TOC in Campanian without any anoxic event, a detailed correlation of TOC with sedimentary facies has been attempted (Figure 2). The Campanian was further divided into various sub-zones based on TOC content and sedimentological variations. It is observed that the units having higher sand content coincides with higher TOC intervals. The Campanian section is deposited in open marine high energy conditions. These Campanian sediments which are composed of terrestrial plants are transported and deposited by turbidity currents/gravity flows in the deep water system. The elevated organic matter content in turbiditic sandstone of the Campanian is similar to the High organic content found in turbiditic sandstone of the Kutie basin, Indonesia where under suitable maturity, the same turbiditic sandstone act as a source and reservoir holding more than 6 tcf of gas and 200 million bbl of oil and condensate (Saller et. Al, 2006).

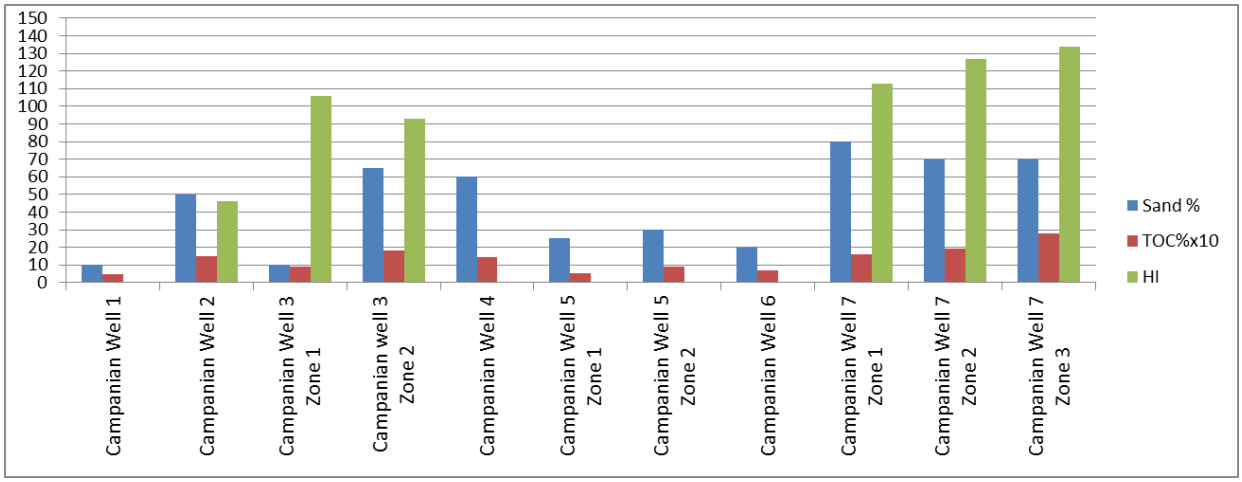

Fig 3: Correlation of TOC (Wt%x10) and HI (mg HC/g TOC)

Synrift Source Rocks

Out of the 7 drilled wells only two wells have encountered the synrift sediments. These synrift sediments have moderate to good preserved source rock interval of Barremian-Valanginian age. The source quality is generally good (Fig 4). The Kerogen types are dominantly gas prone Type III comprising non-fluorescent amorphous debris (43-77% NFA) and vitrinitic kerogen (10-35%). with minor input of flurosence amorphous and Alginite i.e. Type I alongwith some contribution from Type II organic facies. (Fig: 4b)

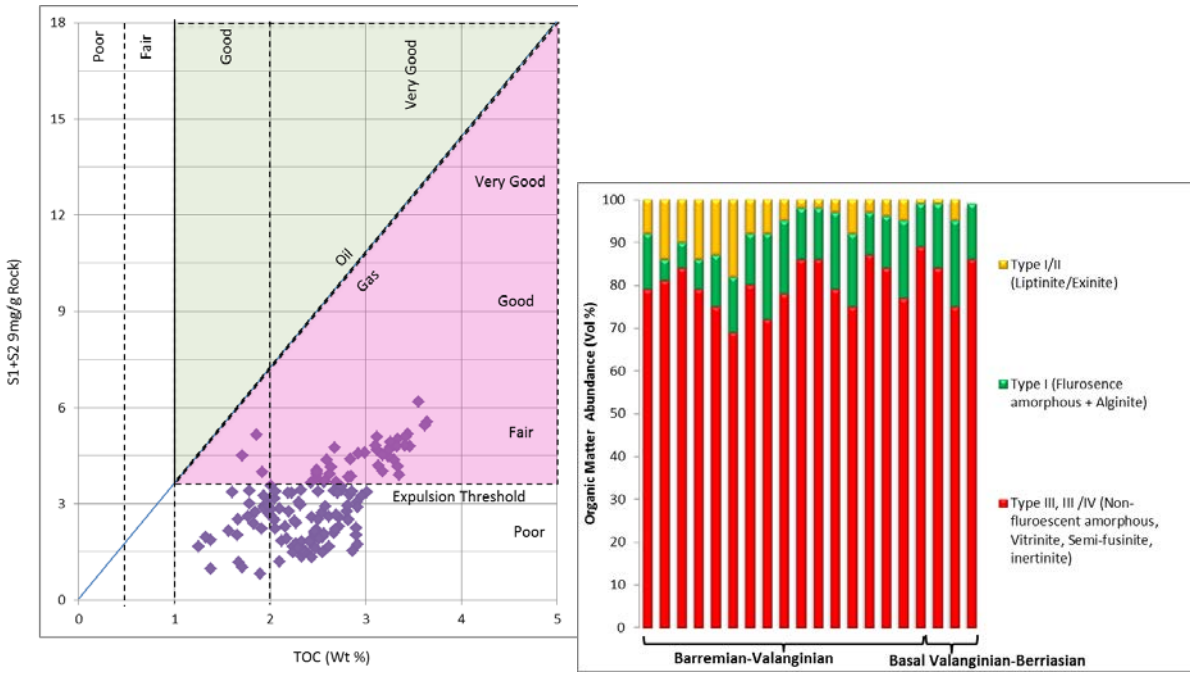

Fig 4a and 4b: Source richness plot of Rock eval S1+S2 (mg HC/g rock) Versus total organic carbon (TOC Wt%) and Maceral plot of synrift section

Hydrogen Index (HI) versus Tmax

The HI value varies upto 185 (mgHC/g Organic carbon). The rift section recorded a Tmax ranging from 415 °C to 479 °C and is consistent with vitrinite reflectance values, suggesting the presence of early to late mature kerogen. (Fig 5)

The post-rift section of all the 7 drilled wells has Rock-Eval Tmax values below 430°C which suggests that the source rock is thermally immature and these fall in Type III organo facies field. They present low HI values which is evident in almost all samples except for few Campanian samples. This type of kerogen is usually a source of gas.

Hydrogen Index (HI) versus Oxygen Index (OI)

The syn-rift samples show that their organic-matter content appears to be dominated by Type III land-plant-material. The post-rift section is also dominated by Type III land plant material. This is evident from palynomaceral and visual kerogen analysis. It is rich in woody components and consequently has lower hydrogen indices and higher oxygen indices than found in lipid-rich and cellulose-poor algal organic matter.

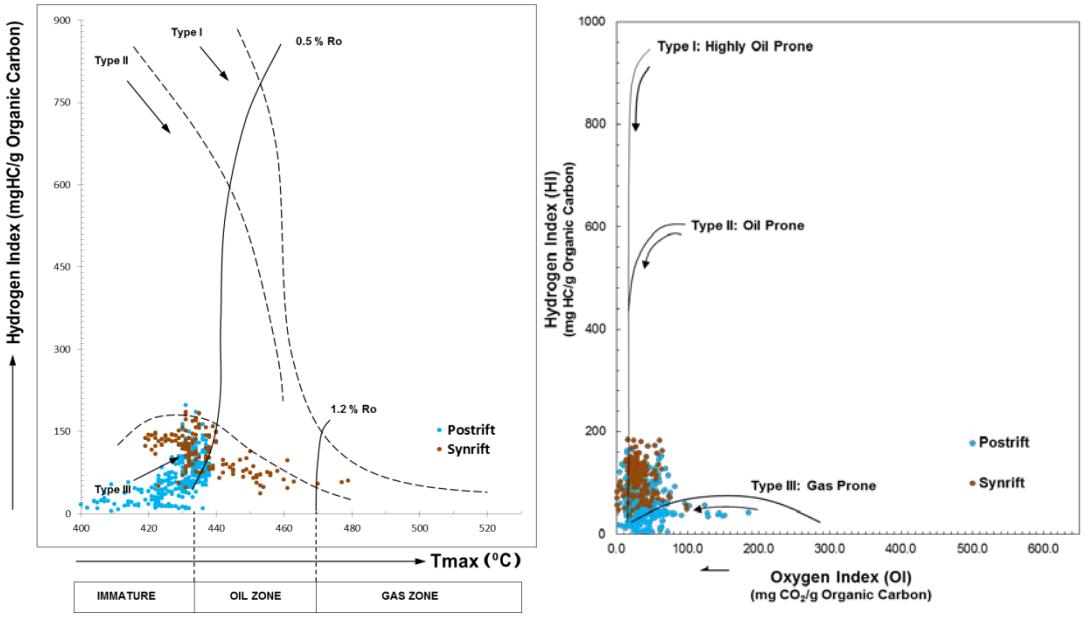

Fig 5a and 5b: HI Vs Tmax and HI Vs OI plots

Conclusions

From the above discussed plots the following can be inferred:

1. Synrift has dominantly Type III organo facies with contribution of Type I organic matter while the postrift section is dominanted by Type III organo facies with minor contribution of Type II.

2. The Campanian sands hold good amount of organic carbon content but is thermally immature in the present locations. However they could be potential source rocks in areas with sufficient overburden thicknesses.

3. Anoxic event recognized using biostratigraphy data but donot show elevated organic carbon content.

4. Synrift samples show good organic matter preservation and their maturities are sufficient for generating oil and gas under suitable conditions.

References

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