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Characterization of organic matter in the Eocene, Offshore East Coast of India

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Abstract

Significant quantities of organic matter accumulated and were preserved in the Eocene. The Indian plate had reached tropical paleolatitudinal position, favourable for the development of carbonates. During the Eocene there were episodes of non-deposition resulting in the formation of condensed section in the deep water regime and also episodes of influx of extra-basinal sediments via turbidite lobe. The offshore lobes consists low carbonate content and locally high amounts of organic carbon. Variations in the abundance and gross composition of the OM content of Eocene sediments were explored with organic carbon content and Rock-Eval pyrolysis of sidewall cores and cuttings from various wells across the East coast of India. The study revealed that the OM of the sediments is immature but is present in sufficient abundance [1-8 % total organic carbon (TOC)] and with a good enough quality [hydrogen index (HI) around 100 mg hydrocarbon/g TOC on average] to constitute a potential source rock. Kerogen and palynofacies analyses of 4 wells confirm that the organic matter is predominantly controlled by input from land-derived terrigenous material and negligible amount of *in-situ* produced marine organic matter. The present study also concludes that the supply decreases exponentially with increasing distance from the shoreline and increasing water depth. However the deepwater fans/lobes tap sources of terrestrial organic matter in the coastal plain and transport it directly into deep water settings. The condensed sections in the deepwater areas could have an increased marine OM content. The finding of these younger source rocks would be of great interest as they could lie at hydrocarbon generation depths today in the unexplored ultra-deepwater regimes of the East coast of India.

Introduction

The ultra-deep water regimes in the East coast of India lack significant oil and gas discoveries. A systematic evaluation of the quantity, quality of the potential Eocene source rock along with the burial and thermal history of the basin could open new avenues for exploration in these areas. Part of the Eocene, is represented by marine limestone on the shelf with a possibly reefal development near the shelf break. The carbonates are particularly well-developed in the Mahanadi and Bengal Basin region. On the continental slope, the limestone changes to pelagic clays represented by shales and detrital carbonates. Lobes are present in offshore area and consist of mixed siliciclastics-carbonates, derived from the onland area. These lobes have good preservation of organic matter. This study mainly aims to investigate the aerial distribution and various geochemical properties of these potential source rocks. The variation of organic matter with respect to the distance from source input and sedimentation rate has been analyzed.

Materials and Methods

The results of Sidewall core, Cuttings from various wells across the East coast of India have been evaluated. The wells are mainly located in the Krishna-Godavari and Cauvery offshore. The location of the wells overlain over the Gross depositional environment map of the Eocene is shown in Figure 1. 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 4 wells.

High resolution Biostratigraphic data have been used to classify the Eocene into various intervals. Seismic and well penetration data have been extensively used to generate the Gross depositional environment map.

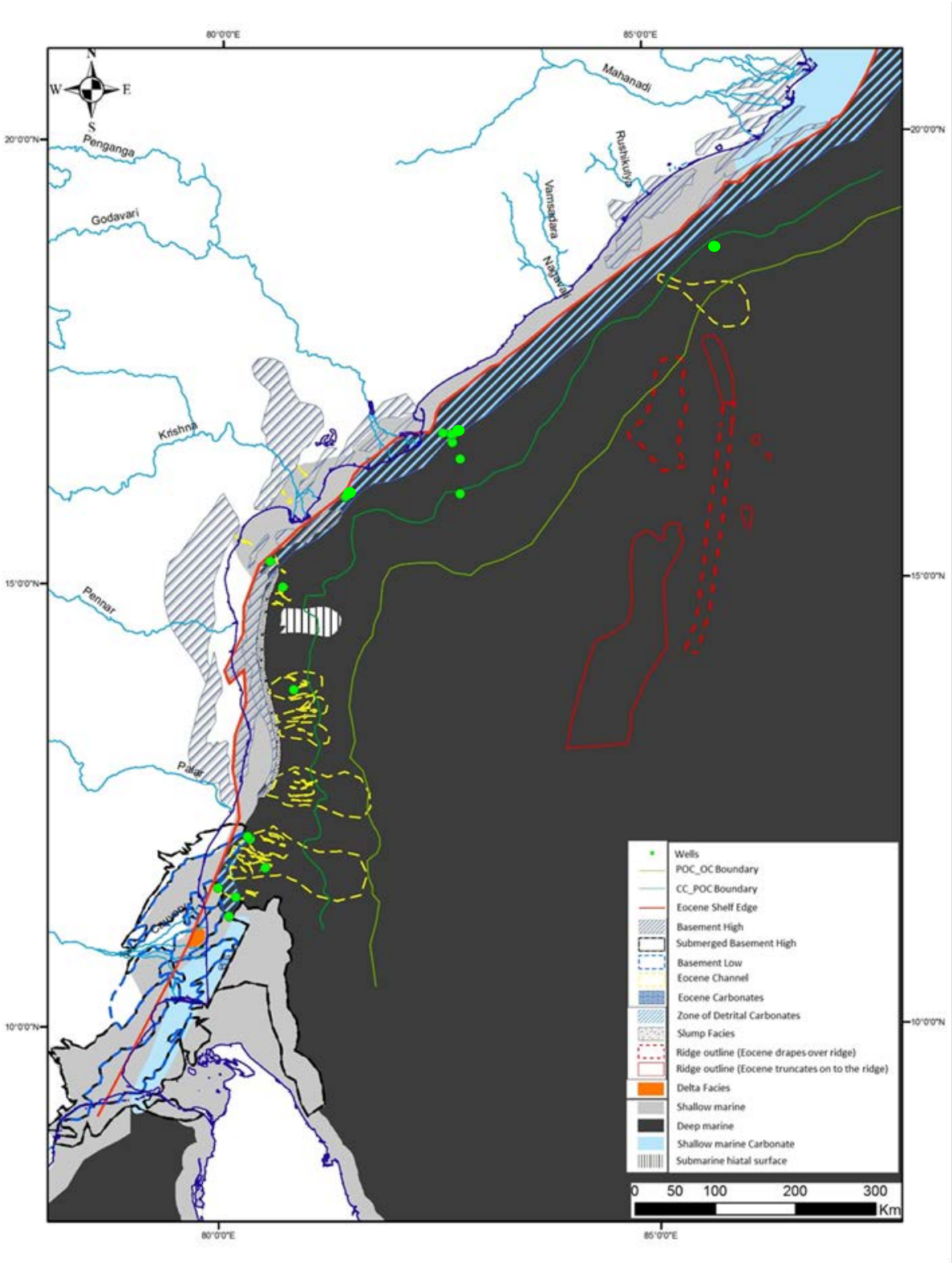

Fig 1: Location wells overlain on Gross Depositional Environment map

Results and Discussions

Source rock richness and generation potential

The results of the TOC contents and Rock-Eval data for the studied chronostratigraphic interval is generated and presented in Figure 2. The TOC values for the Eocene range upto 8.1 wt. % with a mean value of 2.11 wt%. The Eocene yields HI values that goes upto 228mg HC/g TOC. Most of the sample however is typical of gas-prone range (Type III kerogen) with HI values between 100-150 mg HC/g TOC. These TOC and HI values indicate good to very good source rock potential in the Eocene (particularly in the Middle Eocene).

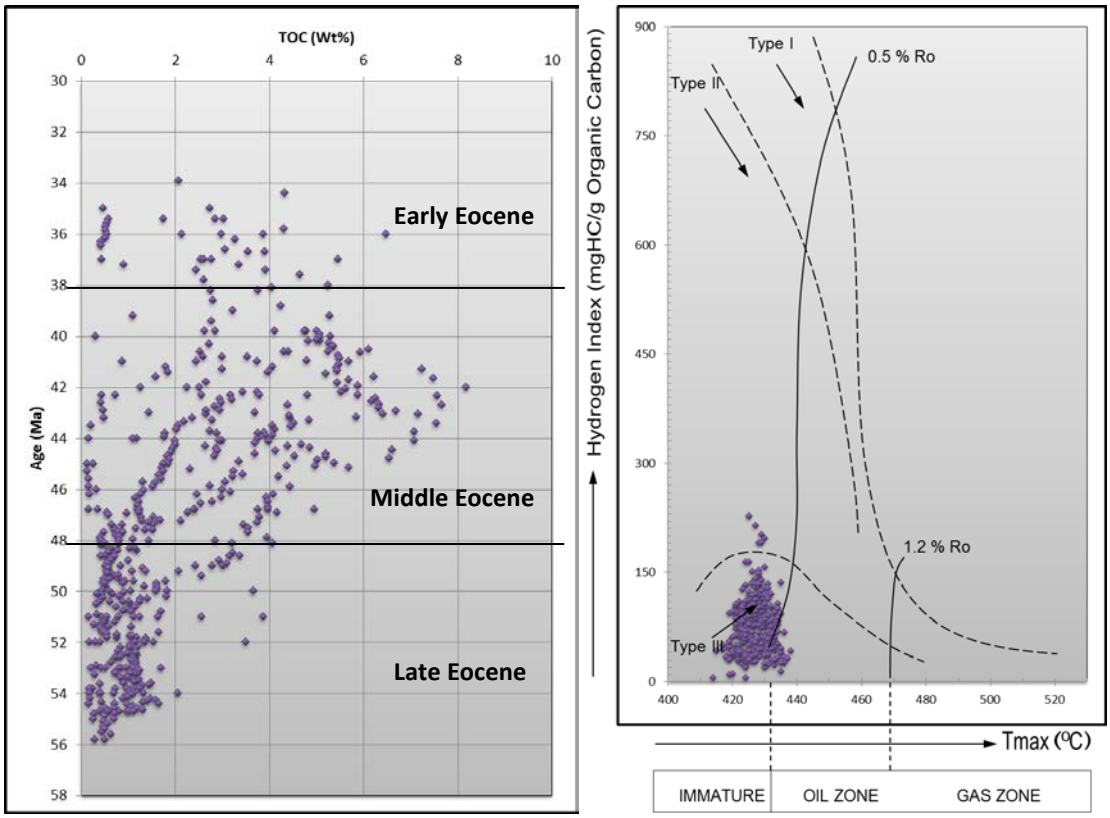

Fig 2: Age Vs TOC (Wt %) and Van Krevelen diagram (HI Vs Tmax (ºC)

Three scenarios were analysed to understand the aerial distribution of organic matter in the Eocene

(1) Depositional architecture Vs Organic matter variability: The high TOC zones coincide with the wells that have penetrated Eocene channel lobes. The Eocene channels are well developed in the Palar-Cauvery area (Fig.1) than the rest of East coast, India. They contain a TOC (Wt%) of 4-8%. Thus the offshore lobes act as main conduits for transportation of organic matter from land derived plants.

(2) Hydrogen index Vs distance from nearest sediment source point: The quality of organic matter decreases drastically as we move from proximal to distal setting (Fig.4). The proximal wells in the Krishna-Godavari area have better preserved TOC than the distal setting wells. A detailed study of the palynomacerals showed that the amount of terrestrial palynomacerals decrease in the distal settings.

(3) Hydrogen index Vs Sedimentation rate: Organic matter is poorly preserved when the consolidated sedimentation rate is more than 20m/my owing to clastic dilution of the organic matter. Above this critical sedimentation rate the TOC values decrease drastically.

Organic Matter (Kerogen) Type

The organic matter type is an important parameter in evaluating source rock potential and has important influence on the nature of the hydrocarbon products. Visual Kerogen analyses of 4 wells show that the organic matter is characterised by a high abundance of Type III gas-prone kerogen (Figure 3), comprising nonfluorescent amorphous (5-83%) and vitrinitic group (10-25%), plus semi-fusinite and inertinite. Oil prone kerogen is present in relatively low amount.

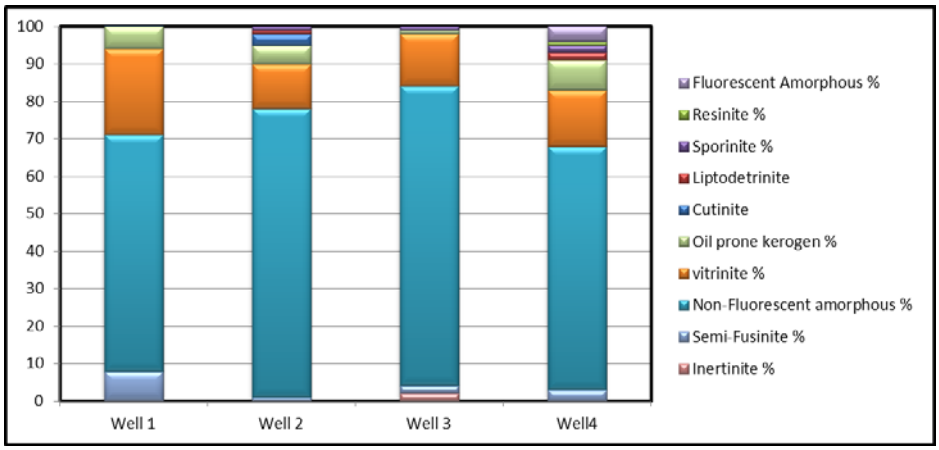

Fig 3: Kerogen maceral plot

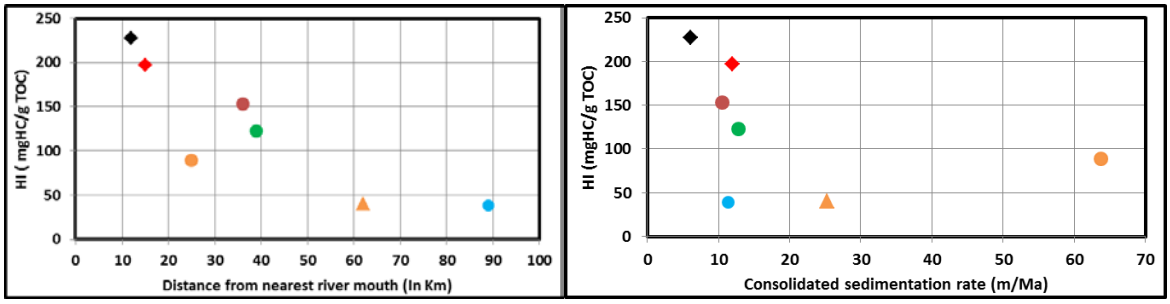

Fig 4: HI Vs Distance from source and HI Vs consolidated sedimentation rate

Conclusions

Results of TOC and Rock-Eval analyses of potential hydrocarbon source rocks in the Eocene stratigraphic intervals of the East coast of India show that:

(1) The prevailing paleogeographic and climatic conditions during the Eocene favoured organic matter production, which led to high organic matter preservation.

(2) The organic matter is better preserved in the proximal setting than in distal offshore areas.

(3) Sedimentation rate act as a vital factor for the dissolution of organic matter. Optimal sedimentation rate of less than 20m/my is required for better preservation of organic matter.

(4) The Middle Eocene has better preservation of organic matter.

(5) The potential Eocene source rocks show dominantly Type III characteristics.

References

Peters, K.E., and Cassa, M.R., 1994, Applied Source Rock Geochemistry. In: The petroleum system-from source to trap; L.B. Magoon and W.G. Dow (ed.). American Association of Petroleum Geologists, Memoir 60, pages 93-117

Hunt, J. M., Petroleum Geochemistry and Geology, W. H. Freeman, San Francisco, 1979.

Tissot, B. P. and D. H., Welte, Petroleum Formation and Occurrence, Springer Verlag, New York, 1984.