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Research paper

Depositional environment and hydrocarbon potential of marginal marine sediments of Eocene from western India: A palynofacies perspective

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ABSTRACT

Palynofacies and palynological data from Eocene sediments documents a comprehensive picture of the nature (degraded, structured, non-structured, amorphous etc.) of organic matter, their distribution, and depositional setting for Matasukh lignite mines of Nagaur Basin in western India. Four Sporomorph Eco Groups (SEG) are defined based on the palynological data viz., Upland SEG, Lowland SEG, Coastal SEG and Tidally influenced SEG. Principal component analysis was used to categorize the organic matter into two palynofacies. Palynofacies-A is dominated by brown Phytoclasts (in particular cuticles) and Palynofacies-B is dominated by amorphous organic matter, mainly derived from terrestrially degraded material. In Palynofacies-B there is a reduced frequency of cuticles and high frequency of non-biostructured amorphous phytoclasts in comparison to Palynofacies-A. Further the Integration of Tidal limit index and Phytoclast preservation index suggest that the sediments were deposited in a proximal setting and were regularly influenced by brackish-marine water. The sand bed with current bedding in which the troughs are draped with lignitic clay indicate the tidal wave action. Tyson's ternary diagram indicates the deposition of these sediments in a sub-oxic to dysoxic condition, rich in Kerogen Type-II/III. Thermal alteration index (TAI) shows that the sediments of Matasukh lignite mine have attained maturation (the characteristic value reached by hydrocarbon generating sediments) to generate dry gas as majority of the organic matter is of Type-III Kerogen with few samples yielding Type-II. These sediments were deposited in deltaic plain, in particular, fluvial dominated marginal marine environment.

1. Introduction

Global tectonic processes resulted in the separation of the Indian plate from Gondwana during Jurassic and Cretaceous and rift basins were formed in western Rajasthan of western India, representing the Phanerozoic geologic evolution of the area. NW–SE and NE–SW trending fault systems largely controlled the growth and geometry of Mesozoic to Tertiary basins in western Rajasthan. The Phanerozoic crustal evolution of western Rajasthan was characterized by the development of three sedimentary basins, the Jaisalmer basin, the Barmer–Sanchor basin and the Bikaner–Nagaur basin (Bhandari, 1999). The Tertiary sequence of Palana and Merta sub-basins in Bikaner and Nagaur districts of western Rajasthan contains marine and freshwater sediments deposited over the rocks belonging to Nagaur Group and Marwar Supergroup (Neoproterozoic). Tertiary sedimentation was initiated with Palana Formation, which is exposed in the Matasukh and Barsingsar mines, and is characterized by carbonaceous shale, lignite, sandstones, clay and minor limestone. The Marh Formation overlies the Palana Formation and comprises of clays interbedded with poorly sorted, coarse-grained, ferruginous sandstones. The Jogira Formation represents the uppermost Tertiary marine facies, as it has yielded foraminifera, pelecypods, echinoids, gastropods, bryozoans and ostracods.

The main aim of this investigation is to interpret the depositional condition and hydrocarbon potential of Eocene sediments of Matasukh lignite mine in Nagaur Basin based on palynofacies analysis. The Nagaur-Merta basin covers an area of 1700 km^2 occupying the districts of Bikaner and Nagaur. The Tertiary sediments in the Nagaur Basin located in the southern part of Nagaur-

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Merta basin, is represented by the Palana Formation conformably overlain by Marh Formation. The lignite of Palana Formation ranges in thickness from 3.20 m to 11.20 m. Matasukh lignite mine is located at a distance of 30 km from Nagaur between the latitude 27° 00′ and longitude 74° 30′ (Fig. 1).

2. Methodology

Thirty five (35) samples were collected from the open face of the lignite mine (Fig. 2) with definite intervals to obtain a fair resolution. The collected samples were subjected to the standard palynological preparation methods as suggested by Traverse (1988) and slides for palynofacies studies were prepared integrating the recommendations of Batten (1996) and Batten and Stead (2005). For palynofacies studies, to avoid the process related bleaching of the organic matter, no oxidizing agent was used. For determination of thermal alteration index based on spore colour, to maintain uniformity and secure the reproducibility, the magnification was kept at 600x and no filters were used. However, for representative photographs for palynomorphs and organic matter, filters were used to obtain better quality on print. The categorization of facies was based on the count of 300 grains per sample. Further the subgroups of Phytoclasts were counted in the same manner for qualitative analysis.

3. Results and discussions

3.1. Palynology

Many researchers have carried out detailed palynological studies on Palaeocene—Early Eocene sediments of Rajasthan in the recent past (Jain et al., 1973; Naskar and Baksi, 1978; Tripathi, 1994; Kar, 1995; Kar and Sharma, 2001; Tripathi et al., 2003). Palaeobotanical studies on Palana Formation of Nagaur Basin are reported by Rao and Misra (1949), Rao and Vimal (1950, 1952) and Sah and Kar (1974). In the present study, palynological data is used to reconstruct the vegetation and its habitat based on the botanical affinity of recovered palynomorphs. Furthermore, an attempt is made to derive an 'ecolog' (a type of biolog which considers relative frequency of palynomorphs in assemblages) (Rull, 2002) and also, to construct a Sporomorph Eco-Group (SEG) model for the studied sediments to visualize the vegetation and depositional settings.

It was observed during the quantitative analysis of the total organic matter of the samples, that the spore/pollen content was found to be less (<10%) due to its dilution by phytoclast and AOM abundance. Majority of the palynomorphs of the assemblage isolated from the sediments in this study are of tropical to sub-tropical climate (Table 1 and Fig. 3). Preponderance of the palynomorphs belonging to tropical-subtropical climate is observed. A warm and humid climate with high precipitation is inferred by the fair amount (6%) of fungal remains in the palynomorph assemblage (Dilcher, 1965). The occurrence of coastal elements viz., *Acanthotricolpites*, *Spinizonocolpites* and *Longapertites* indicate a near shore, swampy vegetation.

3.1.1. Sporomorph Eco Group (SEG)

In 2001, Abbink et al., introduced the term Sporomorph Eco Group (SEG) for the Late Jurassic and Early Cretaceous sediments of the North Sea describing six SEGs viz., Upland, Lowland, River, Pioneer, Coastal and Tidally influenced SEGs. A similar model has been adopted here in an attempt to categorize plant paleo-

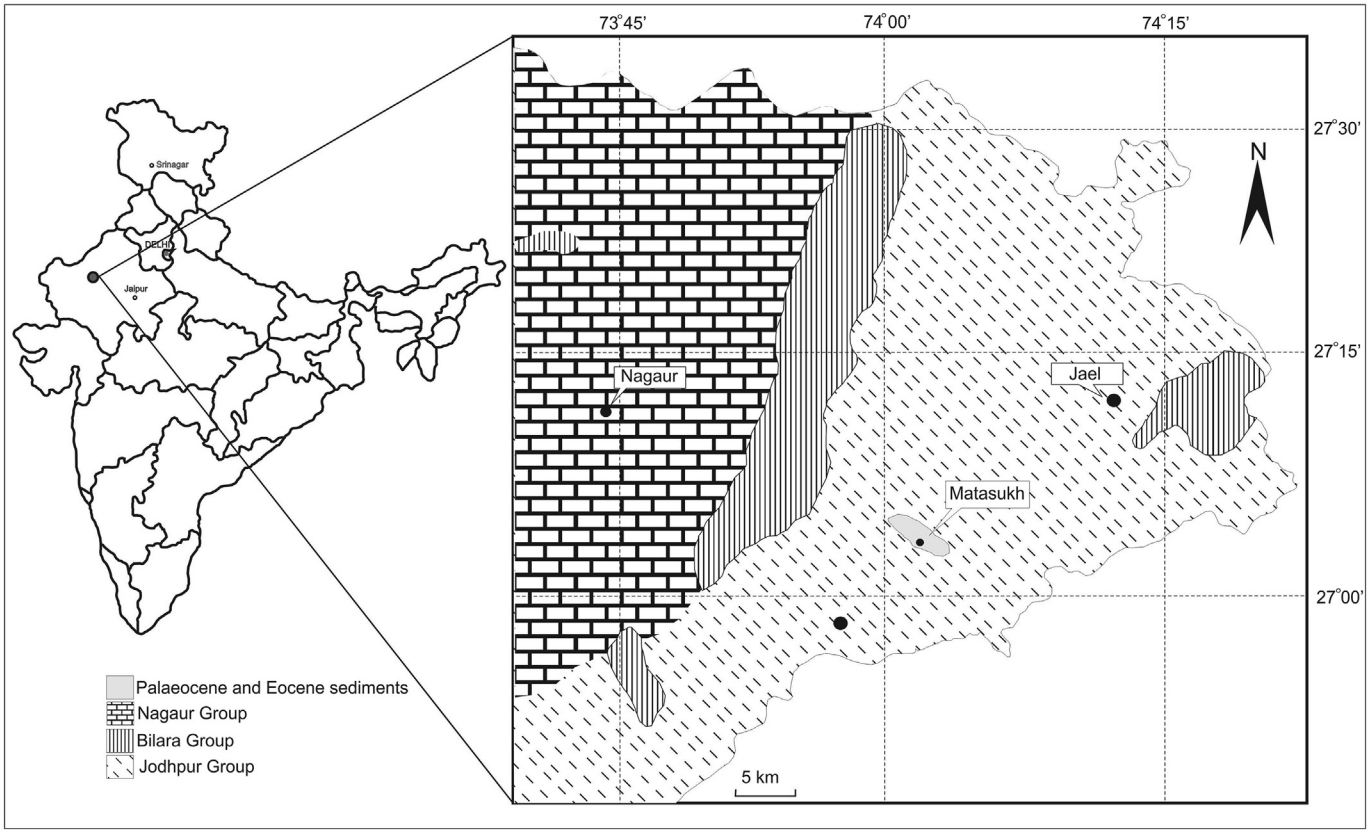

Fig. 1. Location and Geological map of Nagaur basin, Rajasthan, India.