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Research paper

Palynofacies characterization for evaluation of hydrocarbon source rock potential of Lower Paleogene (Thanetian-Ypresian) sub-surface sediments of Barmer Basin, western Rajasthan, India

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ABSTRACT

This paper deals with the hydrocarbon source rock evaluation and depositional environment of Lower Paleogene sub-surface sediments from borehole MMK-26 of Barmer Basin, Rajasthan. Hydrocarbon potential of these sediments are estimated on the basis of plant derived Sedimentary Organic Matter (SOM) analysis. The palynofacies analysis indicate that the sediments are rich in organic matter with amorphous organic matter constituting the majority of the SOM in the lower part of the borehole where as the phytoclasts dominate in the upper part. The dominance of sapropelic facies (Amorphous Organic Matter) at a depth of 152 m and below suggests that these sediments are a good source for hydrocarbon generation. Further the categorized palynofacies components are plotted on Tyson's Amorphous Organic Matter-Phytoclast-Palynomorph diagram which reveal that the studied sediments are characterized by type-II (oil generating) and type – III kerogen deposited in a dysoxic – anoxic shelf. Thermal Alteration Index (TAI) values were determined to asses the organic maturity of the sediments and a maturation value of 2.80–3.0 for the lower part of the bore core suggest that the sediments have attained an optimum maturation level to produce hydrocarbons. The increasing frequency of marine palynomorphs in association with continental components indicates a transgressive phase of sea level during the deposition of the studied sediments.

1. Introduction

In western Rajasthan, the Lower Tertiary sediments of shallow marine deposits occur in Jaisalmer, Barmer and Palana-Ganganagar Basins (Pareek, 1981, 1984; Sinha-Roy et al., 1998). The Barmer Basin has a maximum length of about 100 km and width of about 50 km (Fig. 1). It is a Tertiary basin whose basement comprises of a variety of older rocks including late-Mesozoic formations (Roy and Jakhar, 2002). The Paleocene-Eocene sediments in Barmer Basin are divided into the Fatehgarh, Barmer, Akli, Mataji ka Dungar and Kapurdi Formations (Dasgupta, 1977). Fatehgarh Formation is the lower most unit consisting of Sandstone mixed with clay bands. Lower part of the overlying Barmer Formation consist of fluvial sediments and its upper part is exclusively marine (Tabaei and Singh, 2002). The Akli Formation comprising sandstone, lignite and bentonitic clay successions unconformably overlies the Barmer Formation. Mataji ka Dungar Formation is dominated by pebbly sandstone and ferruginous sandstone with pisolites. Fuller's Earth deposits interbedded with marine limestone constitute the overlying Eocene Kapurdi Formation.

The bore hole MMK-26 was drilled north of Kapurdi near Sutharon-ki-dhani Village (latitude 25° 57′ 51″ N: longitude 71° 21′ 14″ E). The retrieved core shows a repetitive lithology of clay viz., green clay, grey clay, fossiliferous clay, carbonaceous clay and lignitic clay. Lignite is encountered at the lower part of the bore core at a depth of 238.30 m with a thickness of approximately 1 m (Fig. 2). 30 samples were collected from the bore core for palynological as well as palynofacies studies. The Akli Formation unconformably overlies the Barmer Formation with the type locality found in the quarry section at Hathi Singh Ki Dhani (Dasgupta, 1974). The present study was taken up with the aim of inferring the hydrocarbon potential and the depositional environment of sediments from the bore core based on palynofacies. The stratigraphic sequence of the study area is given in Table 1.

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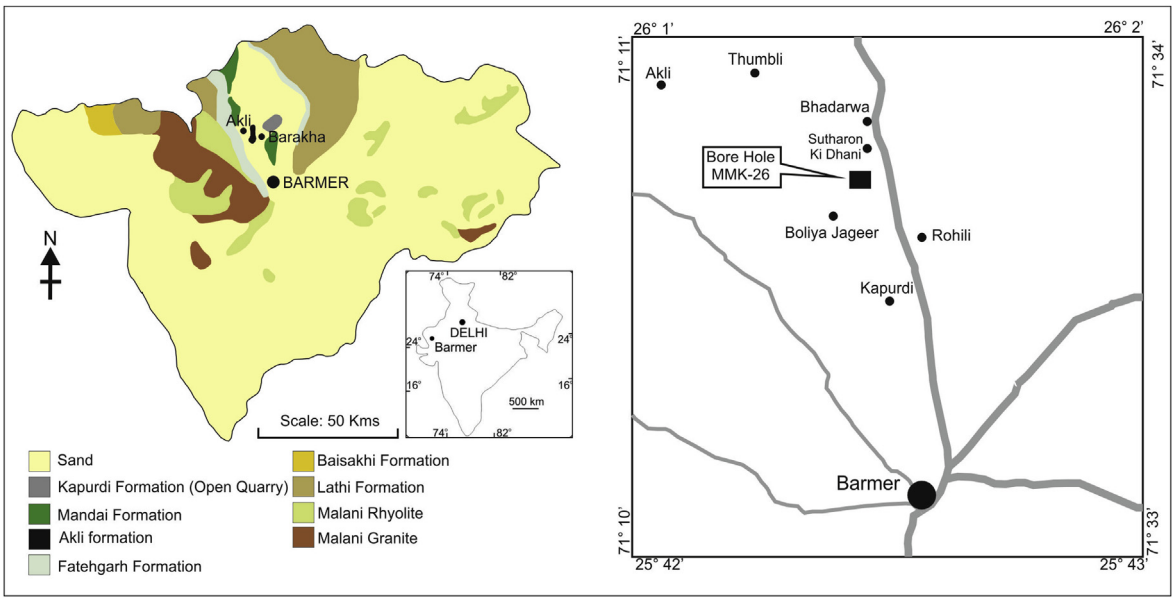

Figure 1. Geological map of Barmer Basin and Location map of bore hole MMK-26.

2. Material and methods

30 samples from varied lithology from the bore core MMK-26 were collected for palynofacies and palynological studies. For palynological studies the maceration technique suggested by Traverse (1988) has been followed for the recovery of pollen-spores. The crushed samples were consequently treated with HCL, HF and concentrated HNO_3 (lignite only) acids for 3–4 days with intermittent washing. The acid free sieved samples (using 500 mesh sieve) were treated with 10–20% KOH.

For palynofacies studies the samples were treated with HCl and HF and washed thoroughly to remove all acids and slides were prepared with Canada Balsam as mounting media. These slides were analysed (following the method of Batten, 1996; Batten and Stead, 2005) under the transmitted and fluorescence blue lights for qualitative and quantitative estimation. The absolute and relative proportions, state of preservation and size of organic matter has been taken into consideration for palynofacies analyses. These are counted in three main groups namely – phytoclasts, palynomorphs and amorphous organic matter as proposed by Tyson (1995) and Mendonça Filho et al. (2002, 2011) for the classification of palynofacies.

For photographic documentation purpose few palynofacies slides were prepared by treating the samples with HNO_3 and the authors have taken care that these slides were not used to evaluate the Thermal Alteration Index.

3. Results and discussions

3.1. Palynology

Detailed palynological work on early Eocene sediments of Rajasthan was carried out by many workers in the recent past (Jain et al. (1973), Naskar and Baksi (1978), Tripathi (1994), Kar (1995), Kar and Sharma (2001), Tripathi et al. (2003)). While in the present study the palynological data is used to derive the habitat of recovered palynomorphs. The recovered terrestrial palynomorphs which are well preserved irrespective of percentage frequency are listed and their vertical distribution is given in Table 2. Contemporary affinity assigned to the recovered palynomorphs in conjunction with their habitat and climatic conditions is

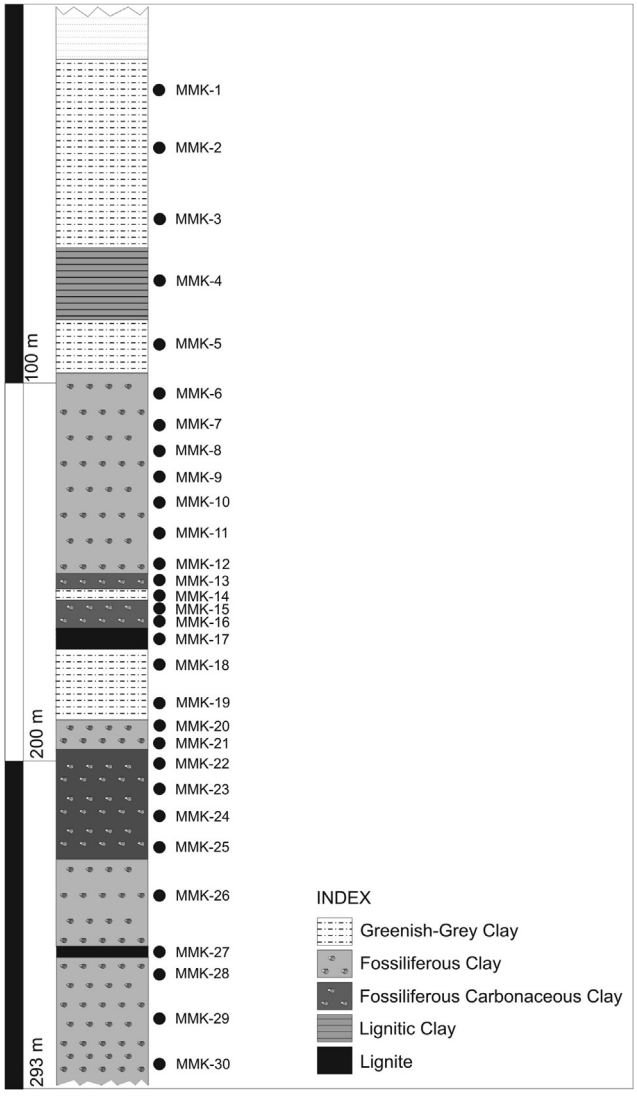

Figure 2. Lithology of bore core MMK-26.