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Organic geochemical and petrographical characteristics of coal bearing Oligo-Miocene sequence in the Oltu-Narman Basin (Erzurum), NE Turkey

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ABSTRACT

In the Oltu-Narman (Erzurum) Tertiary Basin, coals occur in the Oligo-Miocene lacustrine sequence. In this study, *n*-alkane, isoprenoid and saturated-aromatic biomarker distributions of coals in the Sütkans region are found in association with pyrolysis and petrographic data and detailed organic geochemical characteristics, depositional environments and hydrocarbon potential of the coals are propounded.

Huminite is the dominant maceral type in coals (51–84%), telohuminite is in lesser abundance, detrohuminite (especially densinite) and gelohuminite (gelinite) are in higher abundance. Groundwater Influence Index (GWI) and Gelification Index (GI) are quite high for the studied coals whilst Tissue Preservation Index (TPI) and Vegetation Index (VI) are found to be extremely low. According to the results of pyrolysis, coal, coaly claystone and clayey coal samples contain Type II kerogen.

Although Sütkans coals have high ash content (6.28–44.60%, average: 27.99%), their calorific value is quite high (3947–7583 Kcal/kg). Random huminite reflectance values of coals (Vr%) are 0.4–048 (average = 0.44) indicating sub-bituminous B rank. T_{max} values of coal, coaly claystone and clayey coal samples are between 413 and 437 °C. 20S/(20R + 20S), ββ/(αα + ββ) sterane, 22S/(22R + 22S) homohopane, MA(I)/MA(I + II), TA(I)/TA(I + II) and C_{28}TA/(C_{29}MA + C_{28}TA) steroid, MPI, MPR, and MDR ratios which reflect the maturity of coals are very low; MPI-1 is intermediate and moretane/hopane ratio is high.

According to petrographical, palynological, and geochemical data, the coal sequence was formed in an environment changing in character from lacustrine to fluvial, and coals were accumulated in a swamp area with high-water level, high pH, and intense microbial activity represented by suboxic–anoxic conditions.

1. Introduction

Turkey with a reserve of about 15 billion tons has a great potential for lignite deposits. In Turkey there are 126 lignite deposits with reserves of more than 1 million tons and except for a few deposits, most are located in Tertiary basins. These Tertiary lignite occurrences are mostly found in Miocene and partly in the Pliocene deposits. Lignite deposits of Oligocene age are very less and Eocene deposits are rare (Korkmaz et al., 2008).

In the Oltu-Narman Tertiary Basin (Erzurum), coal occurrences are found within Oligo/Miocene and Miocene lacustrine deposits (Bozkuş, 1990) (Fig. 1). Oligo/Miocene coals at different locations in this basin have an economic value and have been exploited for many years as open pits and underground operations, and the coals produced were used as fuel. Coals in the Sütkans (open pit) and Balkaya (open pit and underground operation) regions are currently mined and used as fuel.

Coal occurrences in the region call attention to several investigators, and numerous studies were carried out to propound geologic structure of the region and to determine geologic properties and their economic values as well (Akalın, 1977; Altınlı, 1969; Bayraktutan, 1982; Bozkuş, 1990, 1992; Çetin, 1976; Karayiğit et al., 2002; Lahn, 1939; Lange, 1967; Nebert, 1963; Özcanoğlu, 1960; Tercan, 1987). On the contrary detailed organic geochemical studies on these occurrences are very limited, and thus, in the present study *n*-alkane, isoprenoid and biomarker (saturated and aromatic) distributions of coals were determined and using other data on coals (pyrolysis and petrographic) organic geochemical properties, conditions of deposition environment, and organic matter type were identified. In addition, hydrocarbon generation potentials of coal, coaly claystone and clayey coals of Oligo/Miocene sequence and maturity of organic matter were also investigated.

2. Geological setting

The Oltu-Narman Tertiary Basin was examined in detail by Bozkuş (1990) and in this study the geology of the region was utilized from the work of Bozkuş (1990).

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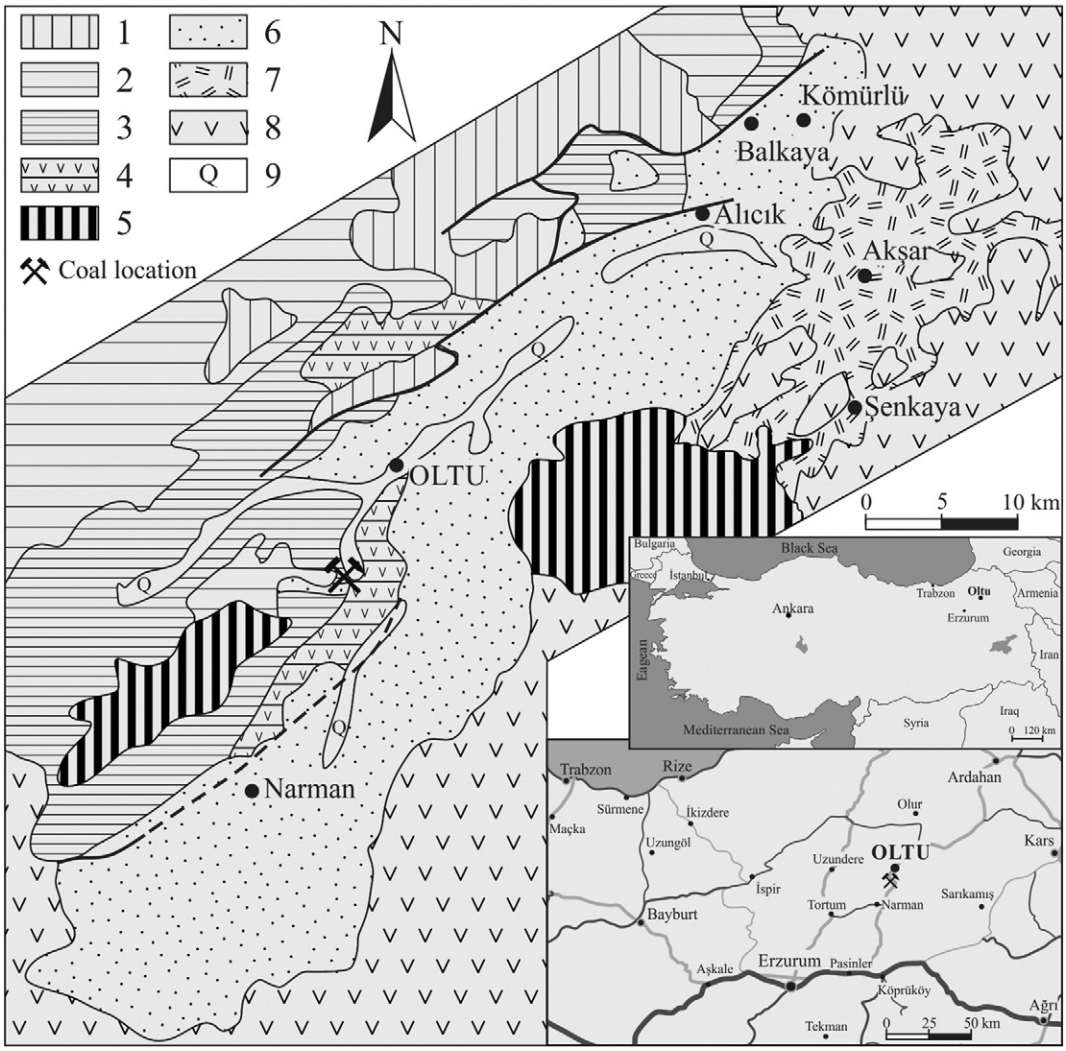

Fig. 1. Geological map of the Oltu-Narman Tertiary Basin (after Bozkuş, 1990). (1) Pre-Jurassic metamorphics and intrusive rocks; (2) Sedimantary sequence; (3) Upper Cretaceous flysch; (4) Volcano-sedimentary sequence of Upper Cretaceous age; (5) Ophiolitic melange; (6) Oltu-Narman Tertiary basin and its deposits; (7) Upper Miocene–Pliocene pyroclastic rocks; (8) Plio-Quaternary volcanics; (9) Alluvium.

The basement in Oltu-Narman Tertiary Basin is composed of Permo-Carboniferous acidic magmatic rocks and upper Cretaceous volcano-sedimentary sequence (Fig. 2). Deposits of the Tertiary Basin start at the bottom with lower-middle Eocene conglomerate, sandstone and siltstone (Dağdibi Formation) which are conformably overlain by the upper Eocene volcano-sedimentary/shallow marine sequence (Karataş/Yassıkuzu Formation). The upper Eocene unit is covered unconformably by Oligocene-aged terrestrial and lacustrine deposits with volcanic interlayers. The sequence continues to the top with Oligo-Miocene and Miocene coaliferous units (Susuz and Kömürlü Formations). Upper Miocene–Pliocene andesite and agglomerates (Penek Formation) conformably set above the underlying units. This unit is conformably overlained by a volcano-sedimentary series with coal interbeddings. The uppermost part of the basin is composed of Plio-Quaternary basalts.

Colas under investigation occur in Susuz Formation of Oligo-Miocene age (Fig. 2). This unit is composed mostly of unbedded and locally thick bedded sandstone, siltstone, and claystone alternation with green-gray colored coal, conglomerate, and pebbly sandstone interlayers. In some fields, the unit appears as very thin-bedded gypsum and claystone alternation. Based on spore and pollen content, the age of unit is suggested to be Oligo-Miocene. Lithological characteristics and fossil content of the Susuz Formation indicate that it was deposited in an environment with a combination of fluvial, flood plain, swamp and lacustrine conditions (Bozkuş, 1990).

Coaliferous sequence of the Susuz Formation was measured and sampled at an open pit site in the northeast of Sütkans village (Fig. 3). At the site base, the sequence is not seen, and the lowermost part is composed of coaly claystones with abundant macro fossils (gastropod). The sequence up to 17 m is composed of coal, clayey coal, and coaly claystone and contains a smaller amount sterile limestone and claystone interlayers. In between 17 and 22 m, coals with sterile limestone, marl, and limestone interlayers are dominant. Below 22 m, the sequence consists of claystone, marl and limestone with coal interlayers. Below 30 m, the sequence is completely composed of claystone, marl, and limestone alternation and contains no coal (Fig. 3).

3. Samples and methods

In order to ascertain the variation in the amount of organic matter content and practically examine general characteristics of organic matter within coal and other units with pyrolysis analysis a total of 28 samples were analyzed. Since TOC content might vary in a short distance in the sequence (that consists mainly of coal, coaly claystone, clayey coal and claystone alternation), the number of samples was taken as high as possible to statistically correctly represent the sequence. 9 coal, 3