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Occurrences and origin of oils and asphaltites from South East Anatolia (Turkey): Implications from organic geochemistry

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ABSTRACT

SE Anatolia hosts the most important oilfields and asphaltite deposits in Turkey. Here, we report on the organic geochemical characteristics of crude oil samples from four wells (Yolaçan-1, Çamurlu-28, B. Kozluca-22 and D. Sınırtepe-1) located to the west of Mardin city, one oil from a well (Özlüce-1) to the north of Batman city, and asphaltite samples from the Avgamasya, Herbol and Seridahle localities.

Reservoir rocks for the oils from the Özlüce-1, Çamurlu-28, B. Kozluca-22 and D. Sınırtepe-1 wells are Lower Cretaceous limestones and dolomites of the Alt Sinan Formation. At well Yolaçan-1, the oil is reservoired in the carbonates of the Lower Cretaceous Mardin Group. At Avgamasya and Seridahle, asphaltites occur in joint systems in the Upper Cretaceous–Paleocene Germav Formation; the Herbol asphaltites are located in the Eocene Gercüş Formation.

Except for the Seridahle asphaltite sample, $\delta^{13}C$ values of all other oils and asphaltites are very similar. Gas chromatograms indicate that while the Özlüce-1 oil sample predominantly contains *n*-alkanes with medium carbon number (C_{13}–C_{20}) the other oil samples predominantly contain *n*-alkanes with low carbon number (C_4–C_{11}).

Except for the Özlüce-1 oil sample, all the other oil and asphaltite samples show similar C_{27}, C_{28} and C_{29} sterane distributions, with C_{29} being the dominant sterane. Based on the C_{28}/C_{29} sterane ratio, the Özlüce-1 oil derives from a younger source when compared to the other oil and asphaltites. The diasterane/sterane, Ts/(Ts+Tm), C_{29}/C_{30} hopane ratios and C_{24} tetracylic terpane abundance indicate that all the oil and asphaltite samples are of similar character except for the Özlüce-1 oil sample, which is characterized by higher diasterane/sterane and Ts/(Ts+Tm) ratios, a lower C_{29}/C_{30} hopane value and lower C_{24} tetracylic terpane content. The C_{31}–R/C_{30} ratio indicates a marine source for all oil and asphaltite samples.

Normal alkane, isoprenoid, biomarker and isotope data indicate that the all the crude oils (with the exception of that from Özlüce-1) and all the asphaltites are geochemically similar and were generated from marine carbonate source rocks. The Özlüce-1 appears to have been derived from a clay-rich source rock.

Based on geology of the basin and their geochemical characteristics, it is suggested that all oils (except Özlüce-1) and asphaltites were generated from Triassic–Jurassic carbonates of the Cudi Group. The source rock of Özlüce-1 oil may be Cretaceous marl or limestone of the Karababa Formation or clay-rich limestone of the Beloka Formation.

1. Introduction

SE Anatolia is the most important oil-producing region in Turkey with major asphaltite deposits also occuring in this region for example at Herbol, Silip and Üçkardeşler in the Mardin-Silopi area, and Avgamasya, Seridahle, Segür, Milli, Karatepe, Nivekara and İspindoruk. These accumulations contain about 80 million tonnes of asphaltite reserves (Korkmaz et al., 2008). These asphaltites have been studied in some detail (e.g. Lebküchner, 1969; Lebküchner et al., 1972; Işiganer, 1985; Ulusahin, 1988; Alkaş, 1989, 1990; Gönenç, 1990; Kavak et al., 2010). Asphaltite is defined as black to dark, comparatively hard, solid bitumens by Hunt (1995). Asphaltites are derived either from naphthabitumen or kerogen and altered during or after migration. They are usually found in veins and fissures (Merrill, 1991). This study focuses on the Avgamasya, Seridahle and Herbol asphaltites which are currently being developed commercially (Figs. 1 and 2). These asphaltites are exploited using open pit/underground systems and are used as fuel in industrial plants (Fig. 3).

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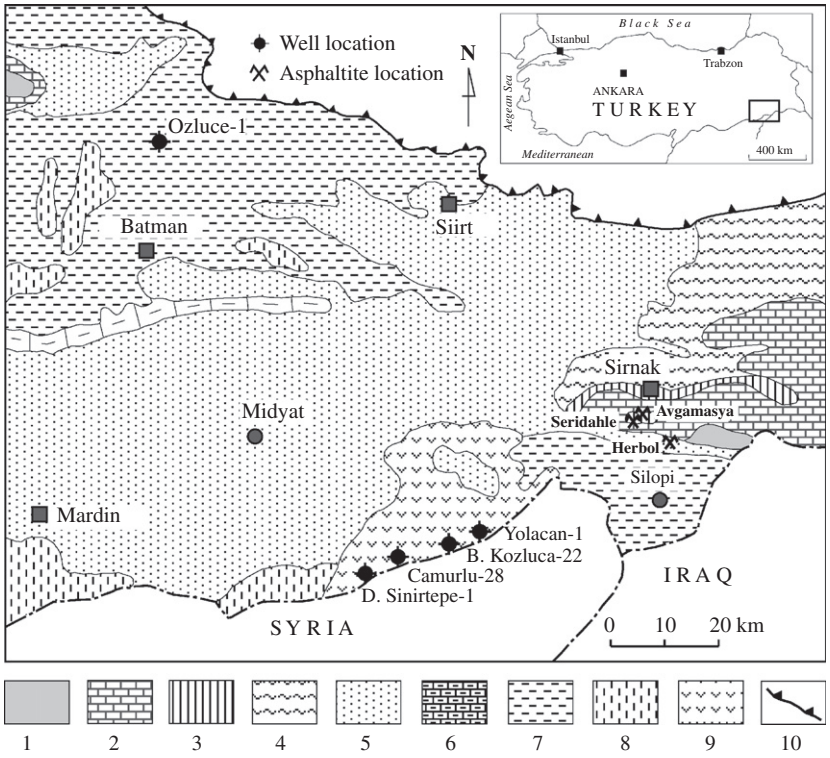

Fig. 1. Simplified geological map (Yilmaz and Duran, 1997) of the study area showing the location of the asphaltite accumulations and oil wells studied. 1. Paleozoic; 2. Jurassic-Lower Cretaceous; 3. Upper Cretaceous; 4. Upper Cretaceous–Paleocene; 5. Eocene; 6. Oligocene—Miocene; 7. Miocene; 8. Pliocene—Quaternary; 9. Subaerial volcanics; 10. Thrust fault.

The Avgamasya asphaltite vein is located at 8 km southwest of Şırnak city, near Avgamasya village (Fig. 1). The vein was emplaced along the NE–SW direction of fault and has a length of 3500 m and a width of 20–30 m. The Seridahle asphaltite vein is located at about 12 km southwest of Şırnak city, near Seridahle village. The length of this vein is 1750 m (NE–SW direction) and this vein width varies between 1.9 and 14 m. The Herbol asphaltite vein is located at about 30 km southeast of Şırnak city. The vein has a length of 1600 m (NW–SE direction) and a width varying between 3 and 26 m (Lebküchner, 1969; Işiganer, 1985). The Avgamasya, Herbol and Seridahle asphaltites were formed due to the alteration of oils that migrate from reservoirs.

SE Anatolia is the sole oil-producing region of Turkey and annual production is about 3 million tones (http://www.pigm.gov.tr). Oil samples were collected from Çamurlu-28, B. Kozluca-22 and D. Sınırtepe-1 wells near the boundary with Syria some 90 km away, to the east of Mardin and the Özlüce-1 well located north of Batman (Fig. 1).

Oils in the Özlüce-1, Çamurlu-28, B. Kozluca-22 and D. Sınırtepe-1 wells are produced from Upper Cretaceous carbonates of the Alt Sinan Formation (Şırnak Group). At Yolaçan-1, the reservoir is the Lower Cretaceous Mardin Group limestone (Fig. 2). Potential source rocks include the Triassic–Jurassic carbonates of the Cudi Group, the Cretaceous Derdere and Karababa Formations, the Upper Cretaceous Beloka Formation, the Cretaceous–Paleocene Sinan Formation, and the Eocene Hoya Formation (Iztan, 2003). In the field, close to Syria–Turkish border, oils occur in Middle Triassic, Middle Jurassic and Upper Cretaceous reservoir rocks and were generated by Middle Triassic marine carbonate and evaporitic source rocks (Abboud et al., 2005).

Although the SE Anatolian oilfields have been intensively studied, few oil-source rock correlations have been established. The purpose of this study is to evaluate the geochemical characteristics of the oils and asphaltites in NE Anatolia and to investigate their geochemical relationships. Similarities and differences based on asphaltite–asphaltite, asphaltite–oil and oil–oil correlations were also investigated to determine the relationship between these deposits.

2. Geological setting

Due to the presence of oils and asphaltite accumulations, SE Anatolia has been the focus of numerous geological studies and drilling programmes (Kellogg, 1961; Altınlı, 1966; Tuna, 1973; Sungurlu, 1974; Eren and Sari, 1984; Perinçek et al., 1991; Bozdoğan et al., 1994; Yilmaz and Duran, 1997). The thick autochthonous succession consists of carbonates and minor siliciclastics ranging in age from Precambrian to Miocene (Fig. 2). The Paleozoic (Derik, Habur, Diyarbakır, Zap and Tanin Groups) is dominated by siliciclastics. Overlying Mesozoic units (Çığlı, Cudi, Mardin, Adıyaman and Şırnak Groups) are mostly carbonates, as are the Cenozoic Şırnak, Midyat and Silvan groups. Allochthonous units include the Bitlis metamorphics, the Hezan Group and the Koçali, Karadut, Yüksekova and Hakkari complexes (Yilmaz and Duran, 1997).

At the Avgamasya, Seridahle, Segür, Milli, Karatepe, Niverakar and İspindoruk localities, asphaltites occur in the Germav Formation, part of the upper Cretaceous–Paleocene Şırnak Group (Figs. 2 and 3). The formation consists of gray, fine- to medium bedded marls and clayey limestones. The Herbol, Silip and Üçkardeşler asphaltites occur in the Eocene Gercüş Formation, part of the Midyat Group, which is composed of sandstones, siltstones, mudstones, gypsum and dolomitic limestones (Figs. 2 and 3) (Işiganer, 1985).

3. Methods and samples

Crude oil samples from the Özlüce-1, Yolaçan-1, Çamurlu-28, B. Kozluca-22 and D. Sınırtepe-1 wells, and asphaltite samples