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Geochemical and isotopic approach to maturity/source/mixing estimations for natural gas and associated condensates in the Thrace Basin, NW Turkey

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Abstract

The Tertiary Thrace Basin located in NW Turkey comprises 9 km of clastic-sedimentary column ranging in age from Early Eocene to Recent in age. Fifteen natural gas and 10 associated condensate samples collected from the 11 different gas fields along the NW–SE extending zone of the northern portion of the basin were evaluated on the basis of their chemical and individual C isotopic compositions. For the purpose of the study, the genesis of CH_4, thermogenic C_{2+} gases, and associated condensates were evaluated separately.

Methane appears to have 3 origins: Group-1 CH_4 is bacteriogenic (Calculated $\delta^{13}C_{C1-C} = -61.48‰$; Silivri Field) and found in Oligocene reservoirs and mixed with the thermogenic Group-2 CH_4. They probably formed in the Upper Oligocene coal and shales deposited in a marshy-swamp environment of fluvio-deltaic settings. Group-2 ($\delta^{13}C_{C1-C} = -35.80‰$; Hamitabat Field) and Group-3 ($\delta^{13}C_{1-C} = -49.10‰$; Değirmenköy Field) methanes are thermogenic and share the same origin with the Group-2 and Group-3 C_{2+} gases. The Group-2 C_{2+} gases include 63% of the gas fields. They are produced from both Eocene (overwhelmingly) and Oligocene reservoirs. These gases were almost certainly generated from isotopically heavy terrestrial kerogen ($\delta^{13}C = -21‰$) present in the Eocene deltaic Hamitabat shales. The Group-3 C_{2+} gases, produced from one field, were generated from isotopically light marine kerogen ($\delta^{13}C = -29‰$). Lower Oligoce ne Mezardere shales deposited in pro-deltaic settings are believed to be the source of these gases.

The bulk and individual *n*-alkane isotopic relationships between the rock extracts, gases, condensates and oils from the basin differentiated two Groups of condensates, which can be genetically linked to the Group-2 and -3 thermogenic C_{2+} gases. However, it is crucial to note that condensates do not necessarily correlate to their associated gases.

Maturity assessments on the Group-1 and -2 thermogenic gases based on their estimated initial kerogen isotope values ($\delta^{13}C = -21‰$; $-29‰$) and on the biomarkers present in the associated condensates reveal that all the hydrocarbons including gases, condensates and oils are the products of primary cracking at the early mature st age ($R_{eq} = 0.55$–0.81%).

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It is demonstrated that the open-system source conditions required for such an early-mature hydrocarbon expulsion exist and are supported by fault systems of the basin.

Keywords: Thrace basin; Turkey; Natural gas; Condensate; Oil; GCIRMS; Carbon isotope; Source; Correlation

1. Introduction

The Thrace Basin is one of the most important gas-producing provinces in Turkey. It is located in NW Turkey and covers approximately 25,000 km^2 (Fig. 1). Sediments in this basin from Eocene to Mio-Pliocene age reach up to 9000 m in thickness. Following the drilling of the first well in 1957, 400 wells and 19 gas-condensate and 2 oil fields now exist in the Thrace Basin.

Several studies have been conducted with special emphasis on the general characteristics of the petroleum geology of the area in the Thrace Basin (Turgut et al., 1991; Coskun, 1997; Inan and Yalçın, 1997; Hoşgörmez et al., 2005). Source rocks suggested (e.g., Hamitabat, Ceylan, and Mezardere fms) for the discovered oils and natural gases have been based on only the organic richness, maturity, and stratigraphic positions of the suspected units (Turgut et al., 1991). Gürgey (1999) and Gürgey et al. (2001, 2003) have used bulk and individual C isotopic values of the natural gas, condensate and oils to correlate these fluids with each other and their source rocks. Consequently, it was proposed that the Eocene Hamitabat shales are the major source of waxy oil and natural gases present in the Thrace Basin. The Oligocene Mezardere shales play a minor role.

The purpose of this paper is to: (1) classify natural gas and condensate groups; (2) estimate maturity levels; (3) identify gas source rocks and kitchen areas; (4) investigate mixing possibilities. The best way of solving these problems has proved to be the use of the stable C isotope ratios (δ^{13}C) of both

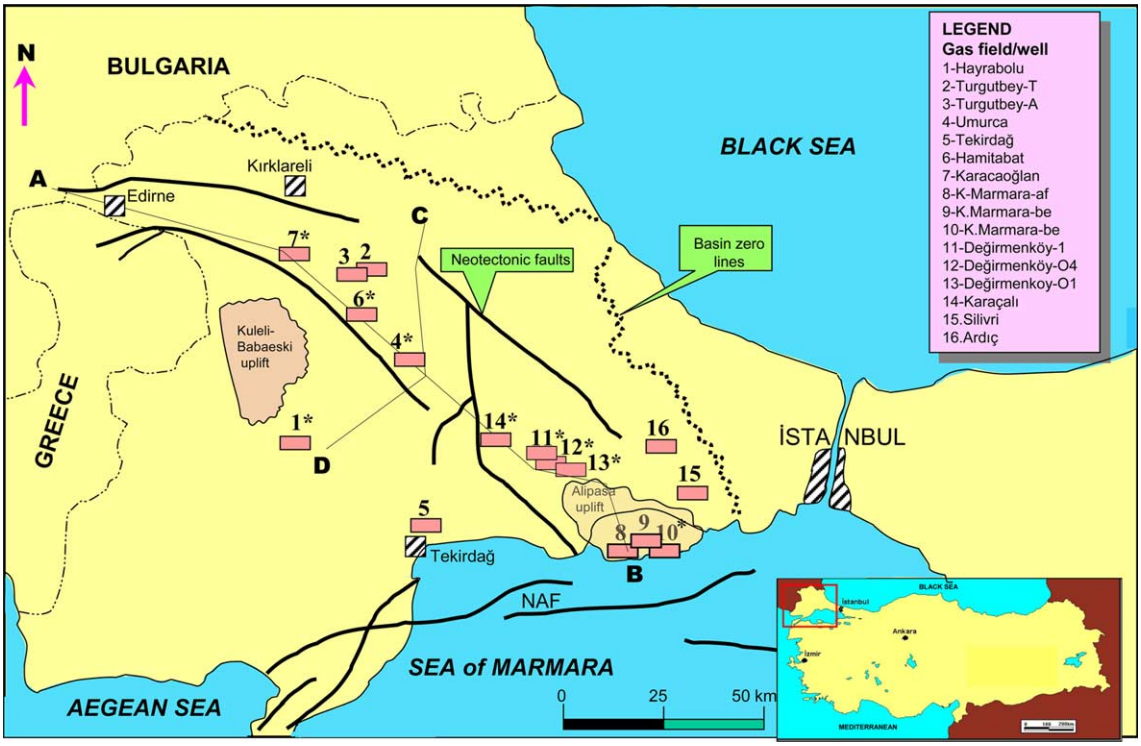

Fig. 1. Map of the Thrace Basin showing tectonic elements and field locations of the natural gas and condensate sampling. Numbers correspond to sampling list in Table 1. (*) refers to both gas and associated condensate sampling sites. NAF, North Anatolian Fault; A–B and C–D geological cross-section directions shown in Fig. 3.