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Modelling of Thrace Basin, NW Turkey using gravity and magnetic anomalies with control of seismic and borehole data

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ABSTRACT

In this study, tectonic features and subsurface structures in the Thrace Basin located in the European part of Turkey were investigated by using gravity, magnetic, well and seismic reflection data in integration. The Thrace Basin is filled by the Tertiary clastic sediments with maximum thickness of about 7.5 km and the basin is very prolific for natural gas potential. In this respect, firstly gravity anomaly map was evaluated and then 3 km upward continued map was prepared. Analytic Signal was applied to the upward continued map. The gravity anomalies were modelled in three and two dimensional methods with the seismic and borehole data control. When the results are compared to the regional geology in the basin, it is determined that the deepest section of the basin is 7.5 km to the north of Hamidiye and around Luleburgaz. In general, average sedimentary thickness of the basin is about 4.5 km.

3 km upward continuation and analytic signal techniques are also applied to the aeromagnetic data. As a result of these applications, it was suggested that the sources of deep seated anomalies observed in the basin are caused by the palaeohighs and the basin is surrounded by the massifs with intensive magnetic anomalies caused by magmatic intrusions. Metamorphic basement outcrops on the Strandja Mountains are evident with the gravity and aeromagnetic responses. However, in contrast, there is a region to the north-northwest of Kirklareli represented by the low gravity contours. It indicates an existence of buried depression on the 3D model. This is explained with the presence of 2 to 3 km thick meta-sedimentary units beneath the Strandja Massif.

1. Introduction

The Thrace Basin is the largest Tertiary sedimentary basin in Turkey. It is located at the European part of Turkey, to the northwest of the country (Fig. 1). The triangular-shaped Thrace Basin is surrounded by Strandja Massif to the north, the Sakarya Continent and Marmara Sea to the south, Rhodope Massif to the west, Istanbul Palaeozoic and Sea of Marmara to the east (Fig. 1). It was created by the extension at the end of Mid Eocene to Late Oligocene times (Gorur and Okay, 1996). The Turkish Petroleum Corporation (TPAO) has investigated the oil and gas potential of the Thrace Basin since 1970. There are over 400 wells drilled, 19 gas-condensate and 3 oil fields discovered in the Thrace Basin (Gurgey, 2009).

In this paper, we present results obtained from the integrated analysis of the gravity, aeromagnetic and seismic data together with the composite logs of selected wells in the Thrace Basin (Demir, 2011; Demir et al., 2011). Although, the basin includes a great variety of data and it has been explored more than 40 years, a basin modelling was not performed until this investigation. It was modelled for the first time in this study using the gravity data. Modelling results and tectonic structures were controlled by the aeromagnetic, reflection seismic and borehole data. In order to suppress the shallow effects, the 3 km upward continuation was applied to the gravity and magnetic anomaly maps. Shapes and locations of magnetised sources were presented using the Analytic Signal (AS) method. According to the results obtained from the upward continuation and AS studies, apparent magnetic anomalies are generally located on the northwestern and southern margins of the basin. The evident anomaly to the west of the basin is caused by the buried palaeohigh named the Kuleli Babaeski Palaeohigh (KBP). In addition, three (3D) and two-dimensional (2D) gravity models of the Thrace Basin were constructed and correlated with the seismic sections (Demir et al., 2011). Correlation and models indicate that the deepest part of the basin was found 7.5 km to the north of Hamidiye and around Luleburgaz towns. Although the metamorphic basement outcrops along with the Strandja Mountains, there is a negative anomalous area beneath the NW of this outcrop which is thought a small sedimentary depression filled by the meta-sediments and basement units thrusted on this depression.

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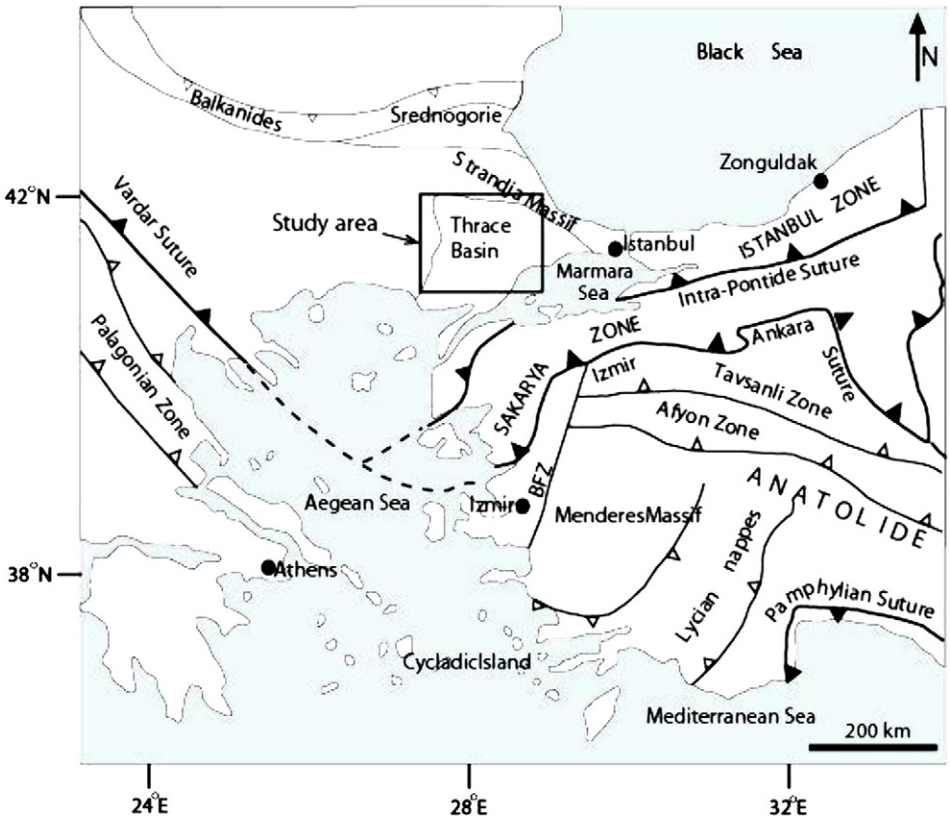

Fig. 1. Tectonic map of Turkey indicating the Thrace Basin (modified from Okay and Tuysuz, 1999 and Okay, 2008). BFZ: Bornova Flysch Zone.

2. Geological setting

There are many geological studies related to the Thrace Basin because of its importance in gas and oil production, and underground gas storage fields in Turkey (e.g. Cinar and Dolek, 1995; Coskun, 1997, 2000; Gorur and Okay, 1996; Hosgormez and Yalcin, 2005; Islamoglu et al., 2010; Okay et al., 2009; Sen et al., 2009; Sengor and Yilmaz, 1981; Siyako and Huvaz, 2007). The study area is subdivided into two parts: (1) The Strandja Massif to the north which forms the basement of the basin and, (2) Eocene–Pliocene sedimentary depocenter consisting of mainly siliciclastics in the rest of study area where the sedimentary basin fill reaches up to 7.5 km in thickness (Okay et al., 2009). Sedimentation covers about 20,000 km^2 (720 miles^2) onshore and it extends beneath the Marmara Sea to the south.

Most of the surface in the Thrace Basin is covered by very young sedimentary units. Quaternary deposition is generally products of the Ergene River that crosses the basin from the centre and distributional channel shape of the Quaternary units indicate a braided river

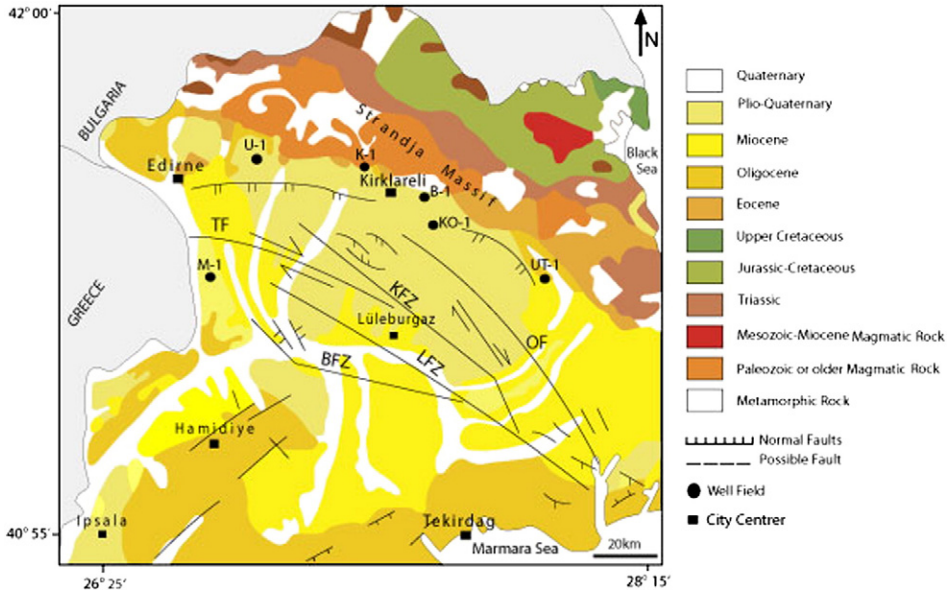

Fig. 2. Geological map of the study area (modified from Bingol, 1989). KO-1: K. Osmancik-1 well; M-1: Meric-1 well; K-1: Karahidir-1 well; B-1: Bayramdere-1 well; U-1: Umur-1 well; UT-1; Uctepeler-1 well; BFZ: Babaeski Fault Zone; LFZ: Luleburgaz Fault Zone; KFZ: Kirklareli Fault Zone; TZ: Terzili Fault; OF: Osmancik Fault.