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# Integrated geophysical investigation of the Galatian Basin around Seben region, Bolu, Turkey



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## ABSTRACT

The Galatian Basin in the northern part of the Central Anatolia is a large, but insufficiently investigated and unexplored basin because of the volcanic cover on the surface. Its great dimensions can only be noticed when the gravity anomaly map of Turkey is examined. In this paper, it is aimed to investigate the subsurface structure in the western part of the Galatian Basin around Seben region, Bolu. The reason behind the study of only western part of the basin is the existence of seismic and a single borehole data that allow the comparison and control the results of potential field modelling studies in integration. The gravity and aeromagnetic anomaly data were processed with the advance potential field data processing methods. Analytic signal method was performed on the aeromagnetic anomaly data to determine the possible eruption centers of the volcanic rocks on the surface in and around the Galatian Basin. According to the Analytic Signal transformation results, there are two possible eruptive area; one of them is located to the south of Bolu and the second one is around the W-NW of Ankara, the capital city of Turkey.

Three-dimensional (3D) and two-dimensional (2D) modelling studies were constructed on the gravity anomaly data to reveal the basement structure of the basin. Findings were compared with the interpretation of seismic sections. Depth of the western part of the Galatian Basin varies between 3 and 12 km, and the basin deepens through the east encouraging acquisition of new seismic data and drilling wells in the deeper part of the basin to the east. The westernmost part of the basin was divided into two sections by a saddle extending from Seben to Mudurnu in the NW–SE direction and the basin gets deeper again to the south of Mudurnu, down to 6–7 km.

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## 1. Introduction

Turkey is geographically divided into two parts; the European part is called as the “Thrace” and the Asian part is named “Anatolia”. The study area is located to the northwestern part of Anatolia (Fig. 1). In this region, most of the previous geophysical research were based on the seismological investigations (i.e. Sato et al., 2004; Aktar et al., 2004; Baris et al., 2005; Zor et al., 2006; Oncel and Wilson, 2006; Bekler and Gurbuz, 2008) because the North Anatolian Fault (NAF) which is one of the most active right lateral strike-slip fault in the world, crosses the northern part of Turkey (Barka, 1992; Karahan et al., 2001). Behaviour of the fault and focal mechanism solutions were studied in these investigations and other types of geophysical data were not used sufficiently. There are limited number of studies based on the gravity and aeromagnetic anomalies of the region in the literature (i.e.

Buyuksarac et al., 1998; Ates et al., 2003, 2008, 2009a,b; Tigli et al., 2012).

Field observations, seismological analyses and focal mechanism solutions define complex pattern for the NAF around Bolu and to the west. It bifurcates at several places and its segments get closer again. Relationship between the NAF and sedimentary basins are not studied in the previous investigations. However, there is a large negative gravity anomaly region to the south of NAF, indicating an existence of a buried basin between Cankiri, Ankara and Bolu triangle (Fig. 2). This basin was not investigated properly in any of previous geophysical studies because it was completely covered by the Galatian Volcanic Complex (Fig. 3). This basin is named as the “Galatian Basin” for the first time in this study, nomenclature is chosen according to the region's ancient historical name. In order to understand the complexities beneath the volcanic cover, spatial analysis is needed. Thus, 3D model of the gravity anomalies were produced in this study. Velocity and density information obtained from the literature and seismic sections were used to construct and to control the models around Seben. In addition, after 2D models were constructed, results and

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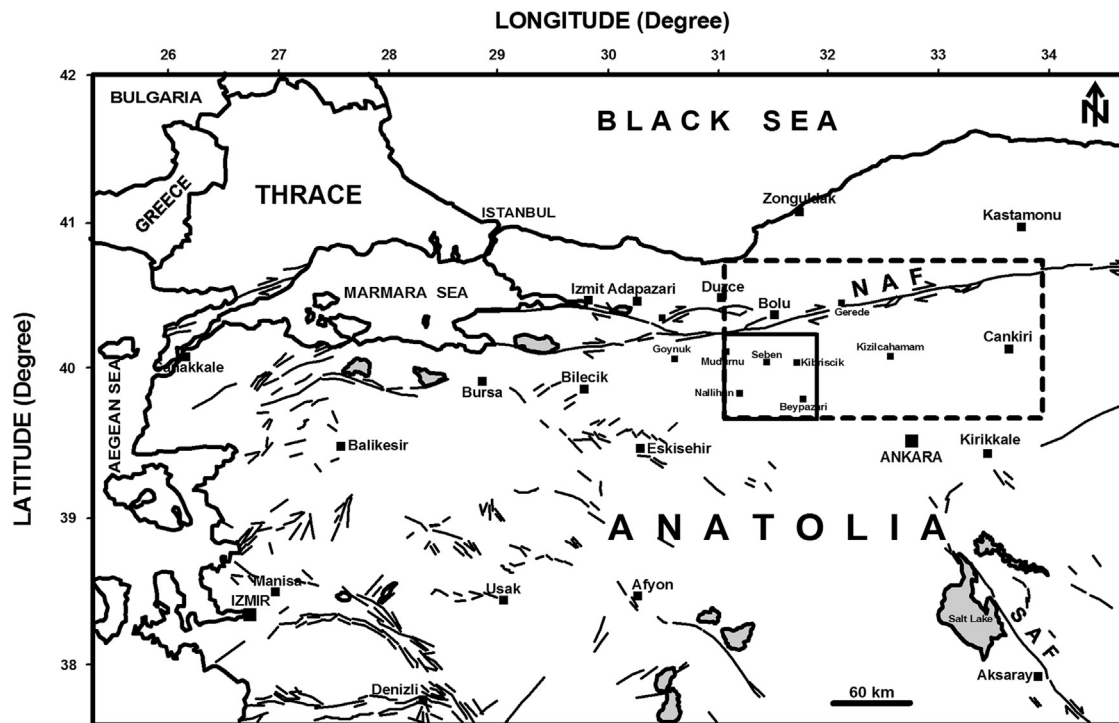


Fig. 1. Location map of the Galatian Basin (large rectangle with dashed line) and the study area (smaller rectangle with solid line in the larger one). NAF: North Anatolian Fault, SAF: Sereflukochisar–Aksaray Fault. Map was modified from the “Active Fault Map of Turkey” by Saroglu et al. (1992).

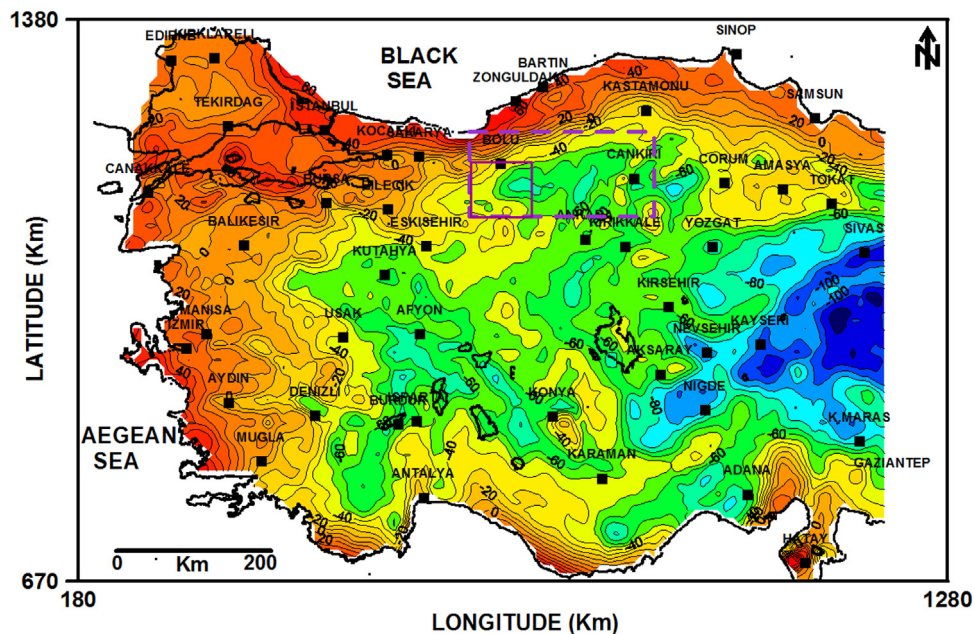


Fig. 2. Gravity anomaly map of the western and central part of Turkey. Contour Interval: 10 mGal. The Galatian Basin is surrounded by the large rectangle (with dashed line) and the study area is illustrated with smaller rectangle (solid line in the larger one).

depths were compared with the basement horizon interpretation in the seismic sections. All results are consistent to each other and they may encourage further exploration activities focusing toward the east of the basin (to the east of Seben) where the basin gets deeper.

## 2. Geological setting

One of the most active tectonic belts in the world is the NAF which extends on the border between the Anatolian and Eurasian

plates. Plates have moved 38 mm/yr since the late Miocene in average relative to each other along the NAF and the average slip rate have slightly accelerated up to 44 mm/yr since the beginning of the Quaternary (Barka and Hancock, 1984). This right lateral fault created the present morphological and tectonic framework of the region. The NAF bifurcates into two branches at the west of Bolu. Branches intercept each other further west and then bifurcate into two branches again toward the Marmara Sea (Fig. 1). Strong earthquakes ( $M > 7$ ) of the August 17th, 1999 and November 12th, 1999 were occurred on the northern segment. In the Marmara Sea to the west; northern and southern branches

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