Tectonophysics 460 (2008) 186–197

Contents lists available at ScienceDirect

Tectonophysics

journal homepage: www.elsevier.com/locate/tecto

Investigation of the deep structure of the Sivas Basin (innereast Anatolia, Turkey) with geophysical methods

K. Mert Onal [a], Aydin Buyuksarac [b], Attila Aydemir [c,*], Abdullah Ates [d]

[a] ITU Faculty of Mines, Department of Geophysical Engineering, 34469, Maslak, Istanbul, Turkey
[b] Cumhuriyet University, Department of Geophysical Engineering, 58140, Sivas, Turkey
[c] Turkiye Petrolleri A.O. Mustafa Kemal Mah. 2. Cad. No: 86, 06100, Sogutozu, Ankara, Turkey
[d] Ankara University, Department of Geophysical Engineering, 06100, Ankara, Turkey

ARTICLE INFO

Article history:
Received 22 November 2007
Received in revised form 24 July 2008
Accepted 8 August 2008
Available online 16 August 2008

Keywords:
Sivas Basin
Kangal Basin
Gravity anomaly
Aeromagnetic anomaly
2D and 3D modeling
Celalli-1 well

ABSTRACT

Sivas Basin is the easternmost and third largest basin of the Central Anatolian Basins. In this study, gravity, aeromagnetic and seismic data are used to investigate the deep structure of the Sivas Basin, together with the well seismic velocity data, geological observations from the surface and the borehole data of the Celalli-1 well. Basement depth is modeled three-dimensionally (3D) using the gravity anomalies, and 2D gravity and magnetic models were constructed along with a N–S trending profile. Densities of the rock samples were obtained from the distinct parts of the basin surface and in-situ susceptibilities were also measured and evaluated in comparison with the other geophysical and geological data. Additionally, seismic sections, in spite of their low resolution, were used to define the velocity variation in the basin in order to compare depth values and geological cross-section obtained from the modeling studies. Deepest parts of the basin (12–13 km), determined from the 3D model, are located below the settlement of Hafik and to the south of Zara towns. Geometry, extension and wideness of the basin, together with the thickness and lithologies of the sedimentary units are reasonably appropriate for further hydrocarbon exploration in the Sivas Basin that is still an unexplored area with the limited number of seismic lines and only one borehole.

1. Introduction and Goals

The Sivas Basin located in innereast Turkey is a 250 km long, 50 km wide and third largest Tertiary basin in the Central Anatolia. It was formed as a result of early Cenozoic collisional events, mainly between the Neo-Tethyan ophiolitic suture zones (Fig. 1); Ankara–Erzincan Suture in the north and Inner Tauride Suture in the south, separating Pontides from the Tauride Platform (Yilmaz and Yilmaz, 2006). Gorur et al. (1998) suggest that the Sivas Basin was formed on the Kirsehir Block within these suture zones as a peripheral foreland basin, following the closure of the eastern part of the Izmir–Ankara–Erzincan Ocean in early Eocene.

Because of the active tectonics and hydrocarbon potential, the Sivas Basin has been evaluated by numerous authors who performed stratigraphic, tectonic and palaeontological studies. Most of the previous works were based on the regional geological observations and surface geology in terms of stratigraphy and tectonic evolution, and to determine the thickness of sedimentary units (sedimentary basin fills as a whole). There are limited amount of geophysical data and related studies in the basin. Seismic reflection studies were accomplished by the Turkish Petroleum Corporation (TPAO) between 1969 and 1976. However the seismic quality is not sufficient for accurate interpretation because of the poor quality resulted from the evaporitic layers and complex tectonics. Moreover, the seismic lines were sparsely shot and processed with the instruments and techniques of seventies. Geophysical investigation with non-seismic methods was performed in the basin by Tanidir and Karli (1996) using the electrical methods. Lately, Buyuksarac (2007) investigated tectonics of inner East Anatolia including the Sivas Basin by using the potential field data and pointed out the tectonic lineaments from gravity anomalies. All of these previous investigations were concentrated on different and local parts of the basin and their results were not verified and correlated with the each other. The main goals of this study are to integrate all available geophysical data, to perform a basin modeling and to reveal the deep structure of the basement. The results presented and discussed in this paper have been derived from the potential field data (gravity and aeromagnetic) and seismic data together with the borehole seismic data.

In this study, the Sivas Basin has been modeled three-dimensionally (3D) using the gravity data in comparison with the seismic reflection and all available geological data. Additionally, two-dimensional (2D) N–S trending cross-sections from the gravity and aeromagnetic data were also constructed to control the 3D model and depth conversion obtained from the seismic sections. In order to realize these modeling studies, density and susceptibility

* Corresponding author. Tel.: +90 312 207 2342; fax: +90 312 286 9049.
E-mail address: aydemir@tpao.gov.tr (A. Aydemir).

0040-1951/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.tecto.2008.08.006

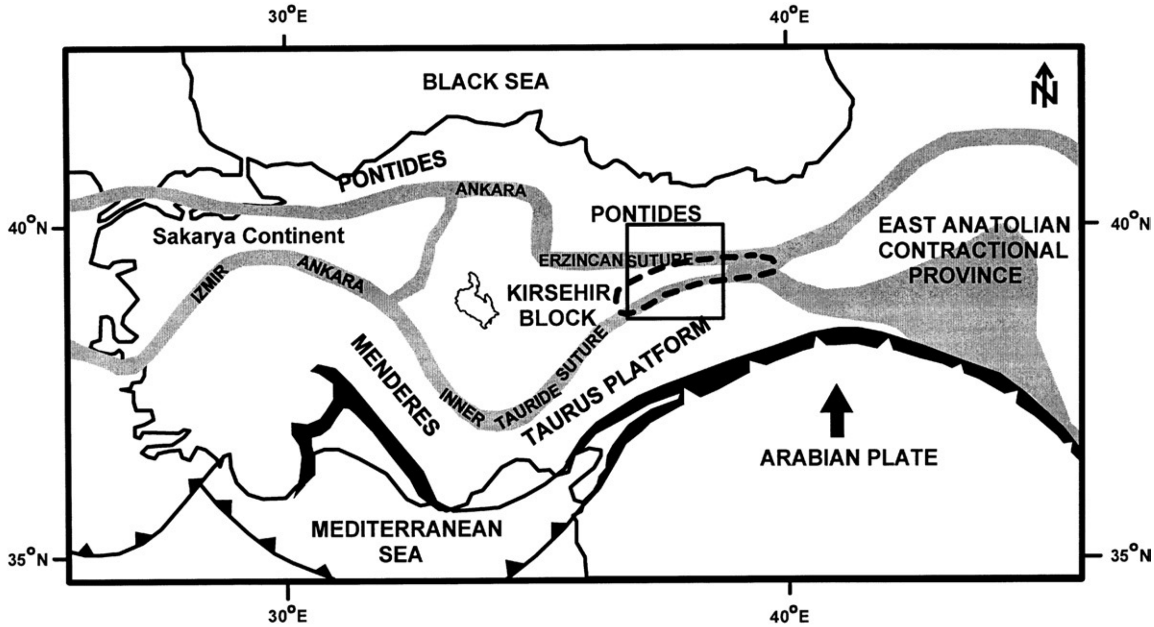

Fig. 1. Tectonic map of the study area. Modified from Gursoy et al. (1998). Dashed line indicates the approximate boundary of the Sivas Basin. The study area is indicated by the rectangle.

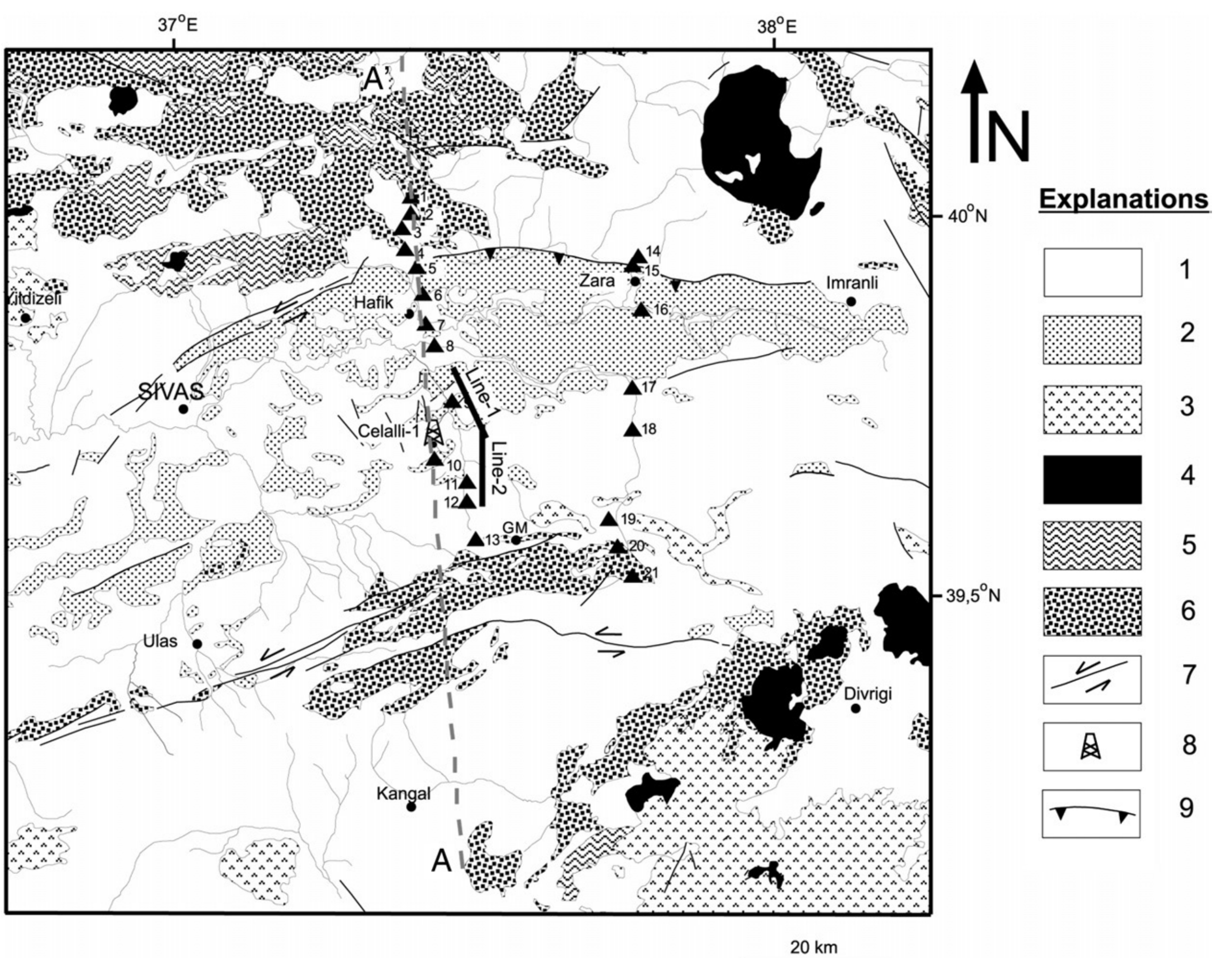

Fig. 2. Geological map of the study area and its vicinity. Modified from Bilgic (2002). 1: Sedimentary units (Upper Cretaceous–Quaternary), 2: evaporitic sedimentary rocks (Lower Miocene), 3: volcanic rocks (Upper Cretaceous–Pliocene), 4: plutonic rocks (Upper Cretaceous–Eocene), 5: metamorphic rocks (Paleozoic–Upper Cretaceous), 6: ophiolitic rocks (Mesozoic), 7: strike-slip faults, 8: Celalli-1 well, 9: thrust faults. Solid triangles indicate in-situ susceptibility measurement and hand sample locations. Dashed line illustrates the 2D modeling profile (Celalli Profile). Solid lines represent seismic sections. GM: Gurlevik Mountain.