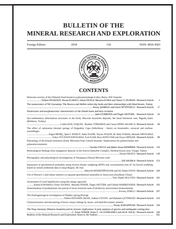
Bull. Min. Res. Exp. (2018) 156: 17-40

**Bulletin of the Mineral Research and Exploration**

http://bulletin.mta.gov.tr



# The neotectonics of NE Gaziantep: The Bozova and Halfeti strike-slip faults and their relationships with blind thrusts, Turkey

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*Research Article*

Keywords:
Neotectonics, SE Turkey, Gaziantep, Bozova Fault, earthquake, structural evaluation.

*Received Date: 02.03.2017*
*Accepted Date: 02.10.2017*

**ABSTRACT**

In the northeast of Gaziantep, east-west trending thrusts, northeast-southwest trending left lateral strike-slip faults and northwest-southeast right lateral strike-slip faults are located. They are typical features of the neotectonics of southeast Anatolia, Turkey. Detailed mapping of these structures and structural data obtained from field studies indicate that east-west trending thrust faults and related fault propagation folds is post-Pliocene. The strike-slip faults that cut these structures should be younger than the thrust fault. On the other hand, the recent seismic activity in the southeast Anatolia (2011.10.23 – M=7.3 Van; 2012.06.14 – ML=5.5 Şırnak-Silopi earthquakes) shows that north-south compression is taken by both thrusting and strike-slip faulting.

## 1. Introduction

In southeast Turkey, at the south of Bitlis suture zone, there are very few articles regarding the detailed investigation of structures in the area defined as the Arabian foreland (Biddle et al., 1987; Perinçek et al., 1987; Çemen et al., 1990; Seyitoğlu et al., 2017) (Figures 1a and b). However, there are many unpublished reports belonging to these structures in the archive of TPAO (Yoldemir, 1985, 1987; Çemen, 1986; Lisenbee 1986, 1987; Yoldemir et al., 1992; Yoldemir and Sefunç, 1999; Sefunç, 2003). In articles, which explain regional and wide areas, the structures in the Arabian foreland have a tendency to be shown simply by fold axes (Şengör et al., 1985; 2008; Yılmaz, 1993; Okay, 2008). However, in Iran the structures in the Zagros foreland were detailedly studied in terms of blind thrusts, strike-slip faults and seismicity (Berberian, 1995; Hatzfeld et al., 2010; Agard et al., 2011; Farzipour-Saein et al., 2009; Joudaki et al., 2016).

Field observations carried out in the northeast of Gaziantep in order to contribute to the deficiency in the literature regarding the detail examination of the structures in the Arabian foreland in southeast Anatolia are presented in this article.

The geological map, which had been taken by a permission of the Turkish Petroleum, Systems Interpretation Unit, was revised by the Arc-Map software and used in simplified form as a result of field observations. The simplification was made to divide the lithostratigraphy in the region into four groups as; the Allochthonous, Cretaceous, Tertiary and Quaternary units (Figures 1c and 2).

## 2. Regional Geology

The study area is located in south of the Besni town of Adıyaman and north of the Halfeti town of Şanlıurfa. The field is restricted by the East Anatolian Fault Zone (EAFZ) in the west and the Bozova Fault in the east (Figure 1c). The left lateral strike -slip Halfeti fault, which is located at the center of the area and extends in NE-SW direction, is one of the youngest fault of the region. It also cuts the asymmetrical anticlines, which

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*http://dx.doi.org/ 10.19111/bulletinofmre.401216*

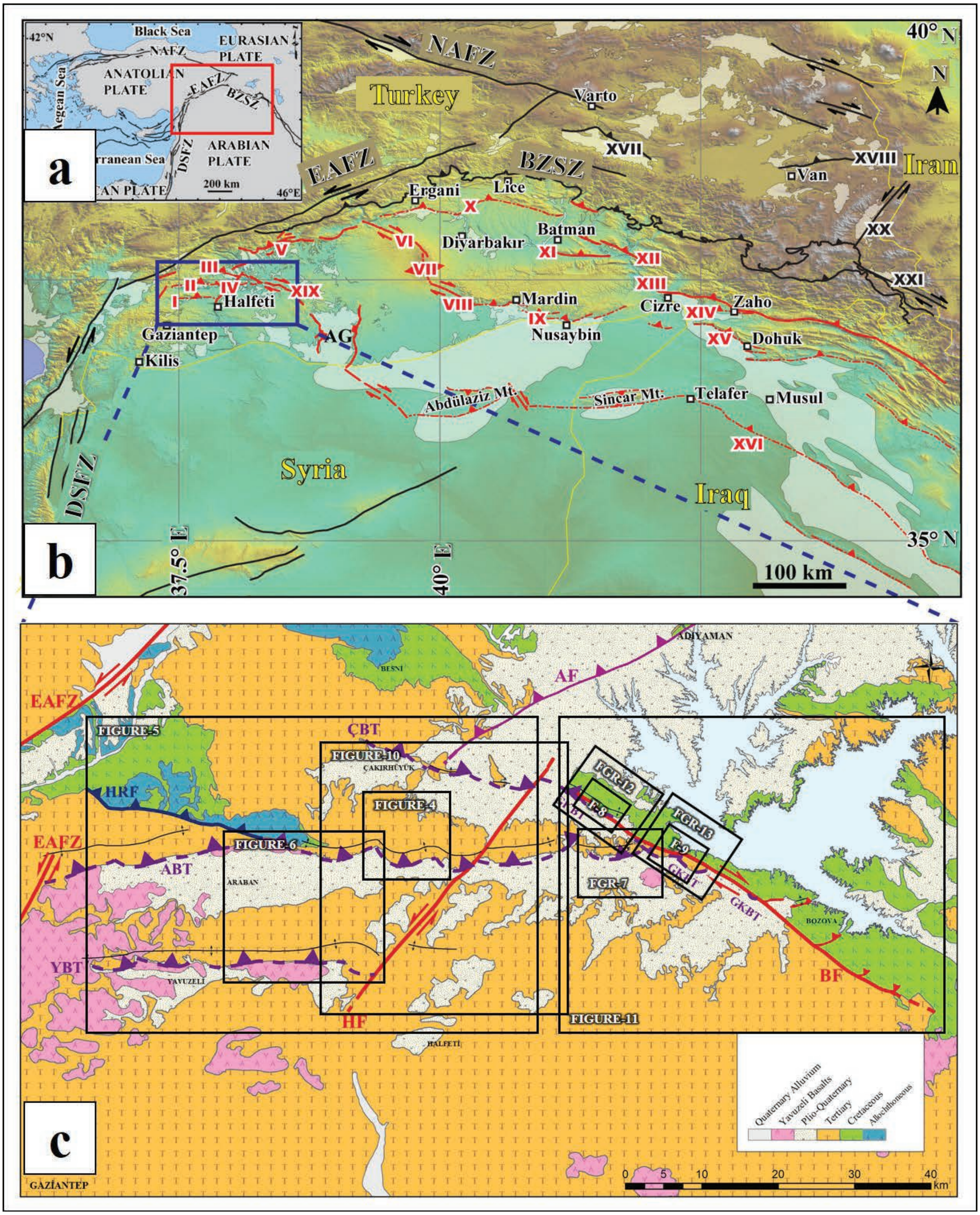


Figure 1- **(a)** The neotectonic elements of Turkey and its close vicinity, **(b)** the map showing the neotectonics of the Southeastern Anatolia, Northern Syria and Iraq (Seyitoğlu et al., 2017**). DSFZ:** Dead Sea Fault Zone (Hall et al., 2005; Krasheninnikov et al., 2005)**, EAFZ:** East Anatolian Fault Zone, **NAFZ:** North Anatolian Fault Zone (Şaroğlu et al., 1992). **BZSZ:** Bitlis-Zagros Suture Zone (Emre et al., 2013**). I-** Yavuzeli Blind Thrust; **II-** Araban Blind Thrust; **III-** Çakırhüyük Blind Thrust; **IV-** Halfeti Fault; **V-** Adıyaman Thrust Zone; **VI-** Northern Karacadağ Fault; **VII-** Karacadağ Extension Fracture; **VIII-** Southern Karacadağ Fault; **IX-** Mardin Blind Thrust Zone; **X-** Ergani-Silvan Blind Thrust; **XI-** Raman Thrust Fault; **XII-** Garzan Thrust Fault; **XIII-** Cizre Thrust Fault; **XIV-** Silopi Blind Thrust; **XV-** Bikhayr Blind Thrust Zone; **XVI-** Sincar-Kerkük Blind Thrust Zone; **XVII-** Muş Thrust Fault; **XVIII-** Van Thrust Fault; **XIX-** Bozova Fault; **XX-** Başkale Fault; **XXI-** Şemdinli-Yüksekova Fault; **AG-** Akçakale-Harran Graben, **(c)** the geological map of the N Gaziantep. (Simplified from the map TPAO, 2014). **EAFZ**: East Anatolian Fault Zone, **AF**: Adıyaman Fault, **HF**: Halfeti Fault, **BF**: Bozova Fault, **HRF:** Harmancık Fault, ÇBT: Çakırhüyük Blind Thrust, **ABT**: Araban Blind Thrust, **YBT**: Yavuzeli Blind Thrust, **GKBT**: Gemrik-Karababa Blind Thrust.

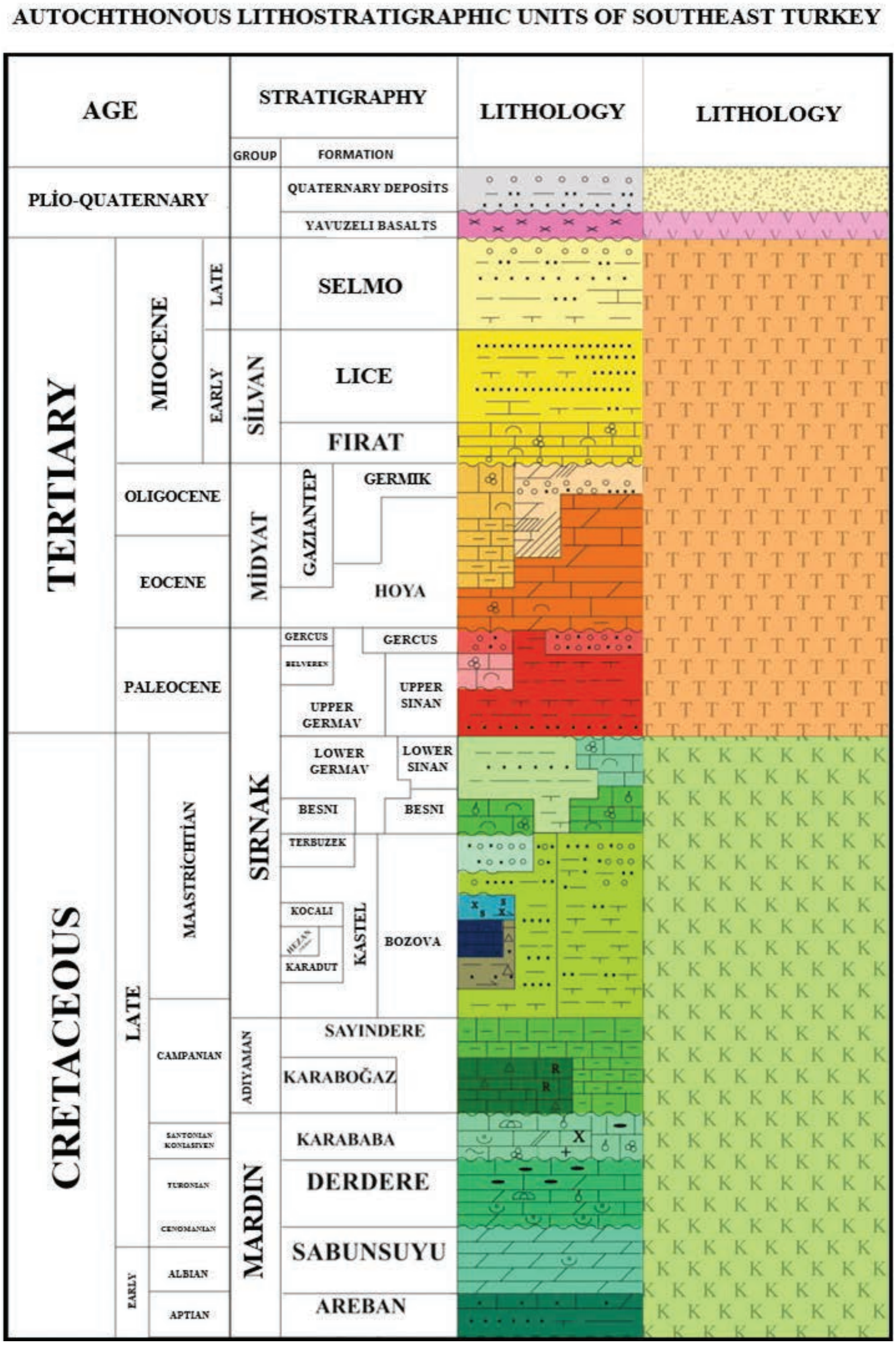


Figure 2- The generalized stratigraphic section of the Southeastern Anatolia (simplified from Güven vd., 1991). The outcropping units in the study area were used in the map by being simplified and presented in the second lithology column.

are formed by Çakırhüyük, Araban and Yavuzeli blind thrusts from north to south, respectively (Çemen, 1990; Seyitoğlu et al., 2017) (Figure 1c). While the Tertiary units (Midyat and Silvan Group) outcrop on highlands, which are formed by the asymmetrical anticlines in the study area, the depression areas in front of these anticlines are covered by the Quaternary alluvium and the Yavuzeli basalts. The Yavuzeli basalts are widely observed in the region towards west (Figure 1c).

## 2.1. Stratigraphy

### *2.1.1. Allochthonous Units*

The Allochthonous units were investigated under two groups as the Koçali and Karadut Complexes. The Koçali Complex was first defined by Sungurlu (1972) and are composed of ultrabasic rocks, volcanics, serpentinites and cherty limestones with radiolarites, and exhibits an irregular internal structure (Yoldemir, 1987). The data obtained from radiolarites within the complex show that the age of formation is Late Jurassic – Early Cretaceous (Tuna, 1973). The Karadut Complex is composed of silicified limestone, cherty, siliceous shales, cherty limestones, conglomeratic much fossilliferous limestones and clayey limestones (Yoldemir, 1987). The data obtained from the various lithologies of the Karadut Complex show that the unit has formed between Cenomanian-Early Turonian times (Sungurlu, 1972; Perinçek, 1978) (Figures 1c and 2).

### *2.1.2. Cretaceous Units*

The Cretaceous units were studied under three groups as: the Mardin, Adıyaman and Şırnak Groups.

*The Mardin Group* is composed of limestone, dolomite, marl, sandstone and shale and has been deposited between Aptian-Early Santonian-Early Campanian in depressions of coastline-shallow sea-inner shelf environments (Schmidt, 1935*a*, Tuna, 1973, Sungurlu, 1972, Erenler 1989, Çoruh, 1991). The Group, from bottom to top, is formed by the Araban, Sabunsuyu, Derdere and Karababa formations and outcrops in the Karababa Mountain (Figures 1c and 2).

*The Adıyaman Group* was deposited on the *Mardin* Group in deep marine environment in the Campanian (Gossage, 1956; Çoruh, 1991; Güven et al., 1991; Perinçek and Çemen, 1991). The units belonging to this group, from bottom to top, is formed by the Karaboğaz and Sayındere formations in the region (Figure 2).

*The Şırnak Group* has been deposited between the Late Campanian-Late Maastrichtian above the *Adıyaman* Group in an environment which shows a transition from deep marine to terrestrial (Tromp, 1940; Çoruh, 1991; Güven et al., 1991). It is formed by the Bozova, Terbüzek, Besni, Germav and Sinan formations (Figure 2).

### *2.1.3. Tertiary Units*

Tertiary units are gathered under Midyat and Silvan Groups.

*The Midyat Group* has been deposited between the Late Paleocene-Early Oligocene times and is composed of marl, shale, sandstone, conglomerate and limestone (Maxson, 1936; Açıkbaş, et al., 1979). It is formed by the terrestrial Gercüş, shallow marine Hoya and deep marine Gaziantep formations (Figure 2).

*The Silvan Group* is unconformably located on the Midyat Group and is formed by the Fırat and Lice formations (Tolun, 1960; Açıkbaş, et al., 1981; Duran, et al., 1988; 1989; Batı, 1991). It was deposited in the Early Miocene on the shelf margin, bank reefs and in deep marine environments, and it is composed of limestone, dolomite, sandstone and shale (Figure 2).

*The Şelmo formation* is of Upper Miocene-Lower Pliocene and was deposited in beach, continental and tidal flat environments. It is composed of conglomerate, sandstone, siltstone and shale (Bolgi, 1961; Çemen, et al., 1990) (Figure 2).

*The Yavuzeli Basalt* is generally composed of reddish-dark brown-dark gray and blackish, unlayered but is sometimes very thick layered lava flow with pores filled with calcite. The age of these basalts are Upper Miocene according to the stratigraphic setting on the map (Ulu, 2002) (Figure 2).

### *2.1.4. Quaternary Units*

They are generally formed by loose compacted pebble, sand and mudstone on river beds and plains, and in the form of pebble, sand and mud stocks on river valleys and plains (Ulu, 2002).

## 2.2. Tectono-sedimentary Evolution

The geology of the southeastern Anatolia is made up of three tectonic belts which extends in the E-W directions. They are divided from south to north as; the Arabian Platform, Fold Belt and the Nappe Zone or the Orogenic Belt (Yılmaz, 1990; Yılmaz and Yiğitbaş, 1990). The units of the Arabian Platform are divided into three groups as the pre-allochthonous, allochthonous and post-allochthonous units based on the emplacement of the Cretaceous allochthonous (Yılmaz, 1993). Pre-allochthonous units are made up of sedimentary deposits ranging from Precambrian to Upper Cretaceous. Of these, the units up to the

Devonian present thick, shallow marine, clastic deposits. However, these deposits have then turned into neritic carbonates between Devonian and Cretaceous (Yılmaz, 1993). The region has taken its recent shape under the effect of three large tectonic activity in Cretaceous, Eocene and in Miocene times (Yılmaz, 1993; Yiğitbaş and Yılmaz, 1996; Robertson et al., 2016).

With the closure of the southern branch of the Neotethys in the Upper Cretaceous (end of Campanian, beginning of Maastrichtian), the allochthonous units settled on the platform was formed by two sections as the ophiolitic assemblage (the Kızıldağ ophiolite) and the mélange underneath (Yılmaz, 1993). The section under the ophiolite is composed of two assemblages which separates from each other by thrust sheets with different and a complex internal structure. Among them, the Koçali Complex has a mélange characteristic (Rigo de Righi and Cortesini, 1964), however the Karadut Complex has a flyschoidal character (Sungurlu, 1974; Perinçek, 1979). This period is also the depositional age of the syn-tectonic Kestel basin which developed in front of the allochthones moving southward (Sungurlu, 1974; Görür et al., 1987; Güven et al., 1991; Robertson et al., 2016).

The northern margin of the Arabian Platform in this period has been affected by the compressional regime and thrusts have formed, whereas; the intra-continental fragmentation have formed in the southern regions and the normal faults constituting the half-grabens in the region have developed (Şemşir et al., 1992).

At the end of the Lower Maastrichtian, the north of the basin became shallow and uplifted because of the global sea level decrease in all over the world (Haq et al., 1988). Thus; the terrestrial Terbüzek formation was deposited in basal sandstone and conglomerate facies over allochthones. However, in foreland areas, where the allochthones cannot reach the neritic carbonates such as the Sinan and Besni and their deep equivalents in lateral direction, the shaley units of the Germav formation continued its deposition (Yılmaz, 1993).

The Middle-Upper Maastrichtian stage ends with a sea withdrawal period which is highly felt in the northern parts of the southeast Anatolian region. The shallow limestones of the Belveren formation were deposited in topographically suitable areas of the region by the sea level that reaches its maximum in Mid-Paleocene starting from the Lower Paleocene, and in deeper parts the Germav formation continued to deposit (Güven et al., 1991).

In last stages of the northward subduction in the Eocene, the first collision of the Arabian-Eurasian continents occurred (Robertson et al., 2016). While the continental Gercüş formation was deposited in northern parts, these units were then overlain by the limestones of the Midyat Group due to the sea level rise. These limestones were then overlain by the limestones of the Oligocene-Early Miocene Fırat formation (Tuna, 1973; Yılmaz, 1984).

In the Miocene time, the northern parts became increasingly deeper in vertical direction due to the movement of the Miocene nappes, and the deposits of the Lice formation including the Early Miocene turbiditic basin facies were developed in this environment (Duran et al., 1988). The Şelmo formation, which developed due to the closure of the basin, was deposited in the terrestrial environment. Even the youngest members of the Şelmo Formation were affected from the continuous compression in the region (Öğrenmiş, 2006). All these units were then overlain by the Yavuzeli basalts, which have been effective up to historical times starting from the Upper Miocene (Ercan and Fujitani, 1990; Ulu, 2002). Finally; the Yavuzeli basalt were covered by Quaternary alluvium in the area.

## 3. Young Structures in the Study Area

The most distinctive structural elements in the area are Suvarlı, Karadağ and Faldağı anticlines associated with Çakırhüyük, Araban and Yavuzeli blind thrusts (Seyitoğlu et al., 2017). These anticlines are fragmented by the NE-SW trending East Anatolian Fault (EAF) in the west and NW-SE trending Bozova-Halfeti (Kemerli) Faults in the east (Figure 1c).

Çemen (1986, 1990) stated that the Suvarlı anticline was formed by the Late Miocene Harmancık reverse fault. It is also mentioned in the report that, the Harmancık Fault ends in the Kemerli Fault, but the the Suvarlı anticline has been shifted 500 meters by the Kemerli Fault. The investigations carried out in this area were performed by using the studies of Çemen (1986, 1990). Sefunç (2003) approved the relationship of the Suvarlı anticline with the Harmancık Fault in the Turkish Petroleum report in which the seismic data had been used. He also acclaimed that the Harmancık Fault did not end within the Kemerli Fault, but connected with the Bozova Fault in the east.

The neotectonic structures in the Southeast Anatolia under the N-S contraction have generally developed as E-W thrusts, N-S opening structures, NE-SW left lateral strike-slip faults and NW-SE right lateral strike-slip faults (Şengör et al., 1985; Dewey et al., 1986; Seyitoğlu et al., 2017). First, the E-W trending blind thrust systems then the strike-slip fault systems will be considered in the study area.

### 3.1. Çakırhüyük, Araban and Yavuzeli Blind Thrusts

The most remarkable morphology in the area, which remains between the south of the Besni town of Adıyaman and the NE Gaziantep, is the E-W extending Quaternary alluvial plains where Çakırhüyük, Araban and Yavuzeli settlements are located from north to south (Figure 1c). These plains are restricted by the NE-SW trending EAFZ in the west and cut by the Halfeti Fault in the east (Figure 1c). The common features of these plains in which Çakırhüyük, Araban and Yavuzeli settlements are located is that their northern margins are restricted by the E-W and WNW-SSE oriented asymmetrical anticlines. As it is clearly seen in the remote sensing analyses and the geological map (TP Systems Interpretation Unit) carried out in the anticlines, which was formed by Eocene Midyat Limestones, the southern limbs of anticlines are steeper than the northern limbs. The drainage system, which developed according to this positioning, is shorter in the south of the fold axis, but is longer in the north (Seyitoğlu et al., 2017) (Figures 3a, b, c). The locations of the asymmetrical anticlines

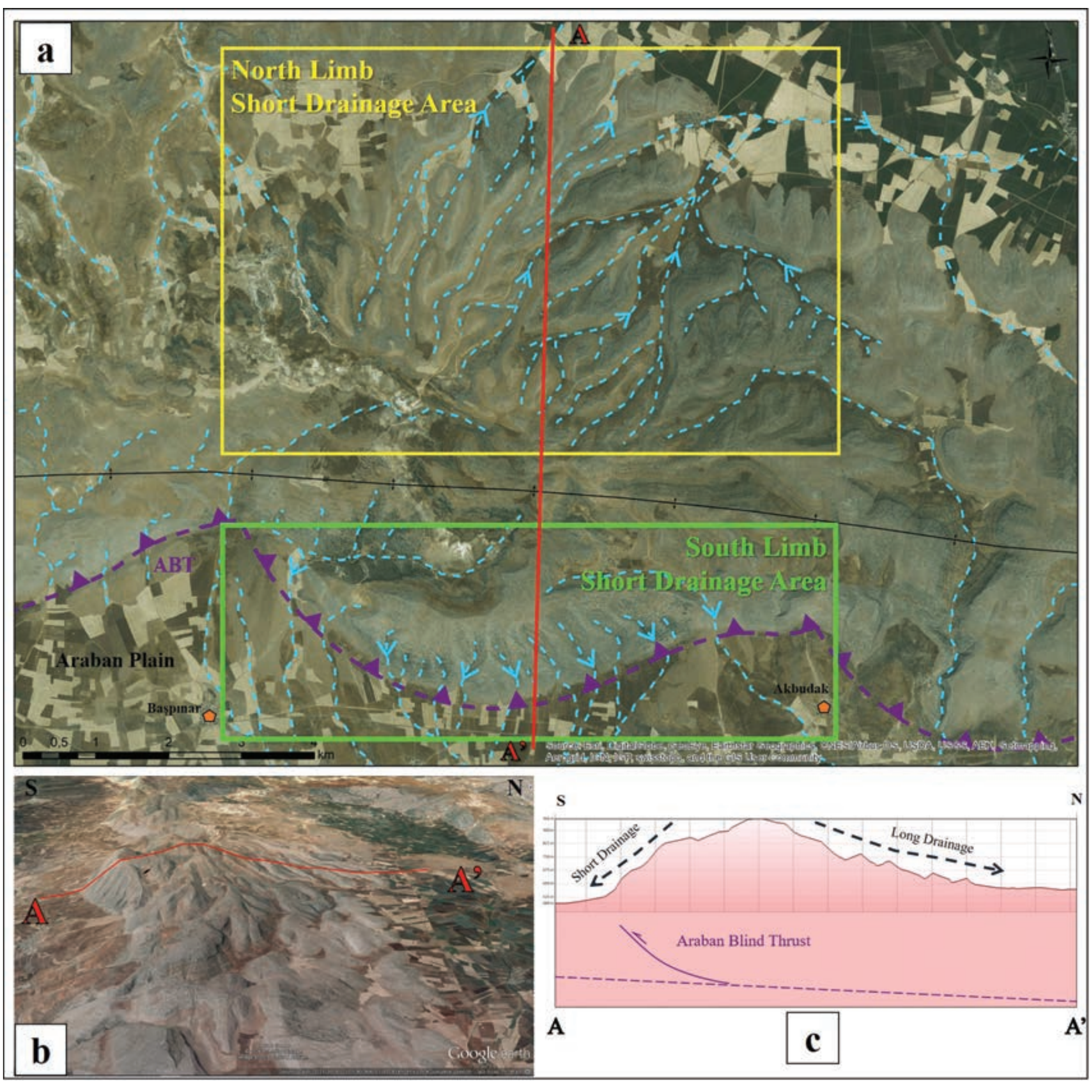


Figure 3- **(a)** Drainage network that developed on the northern and southern limbs of the Gemrik asymmetrical anticline. **ABT**: Araban Blind Thrust, **(b)** Google Earth image showing different dips on the southern and northern limbs of the Gemrik asymmetrical anticline, **(c)** topographical section taken both from the northern and southern limbs of the Gemrik asymmetrical anticline and short/long drainage relationship.

remind the fault propagation folds that developed in the hanging wall blocks of the blind thrusts dipping in N-NE directions. The blind thrusts, which form these asymmetrical anticlines, should have restricted the northern margins of the Çakırhüyük, Araban and Yavuzeli plains (Seyitoğlu et al., 2017) (Figures 4a, b, c). In the Araban Plain for different purposes drilled wells by Turkey Petroleum , MTA and DSI to be seen in the (Figure 5a, b, c), the thickness of the Quaternary units deposited on the Yavuzeli basalt reaches 380 meters in the north just in front of the blind thrusts, but gradually decreases towards south. It shows that

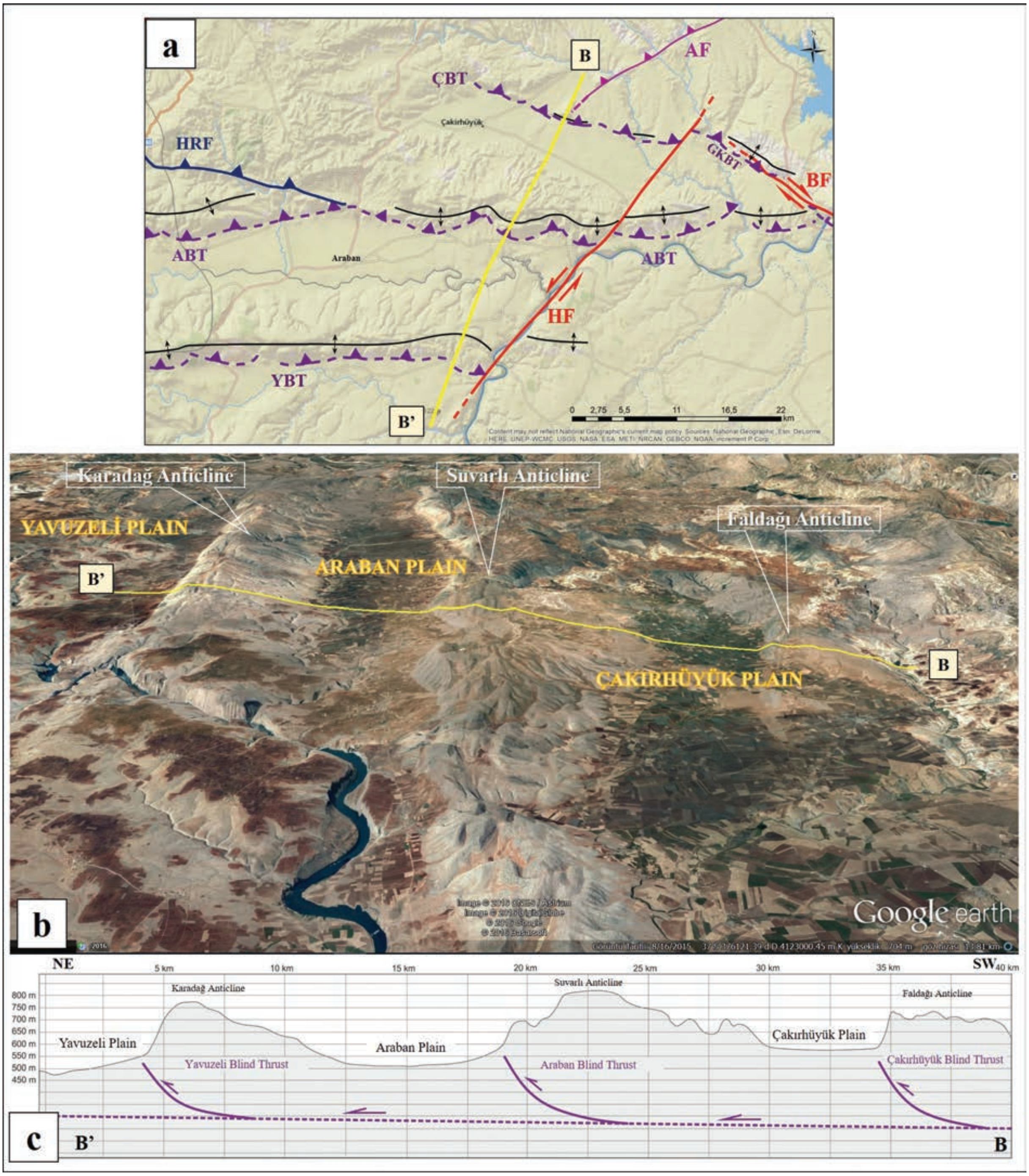


Figure 4- **(a)** Yavuzeli, Araban, Çakırhüyük plains and the map showing the structural elements. **AF**: Adıyaman Fault, **HF**: Halfeti Fault, **BF**: Bozova Fault, **HRF**: Harmancık Fault, ÇBT: Çakırhüyük Blind Thrust, **ABT**: Araban Blind Thrust, **YBT**: Yavuzeli Blind Thrust, **GKBT**: Gemrik-Karababa Blind Thrust, **(b)** Google Earth image of the Yavuzeli, Araban, Çakırhüyük Plains, **(c)** Yavuzeli, Araban, Çakırhüyük Blind Thrusts and the NE-SW directed topographical section showing the locations of the plains.

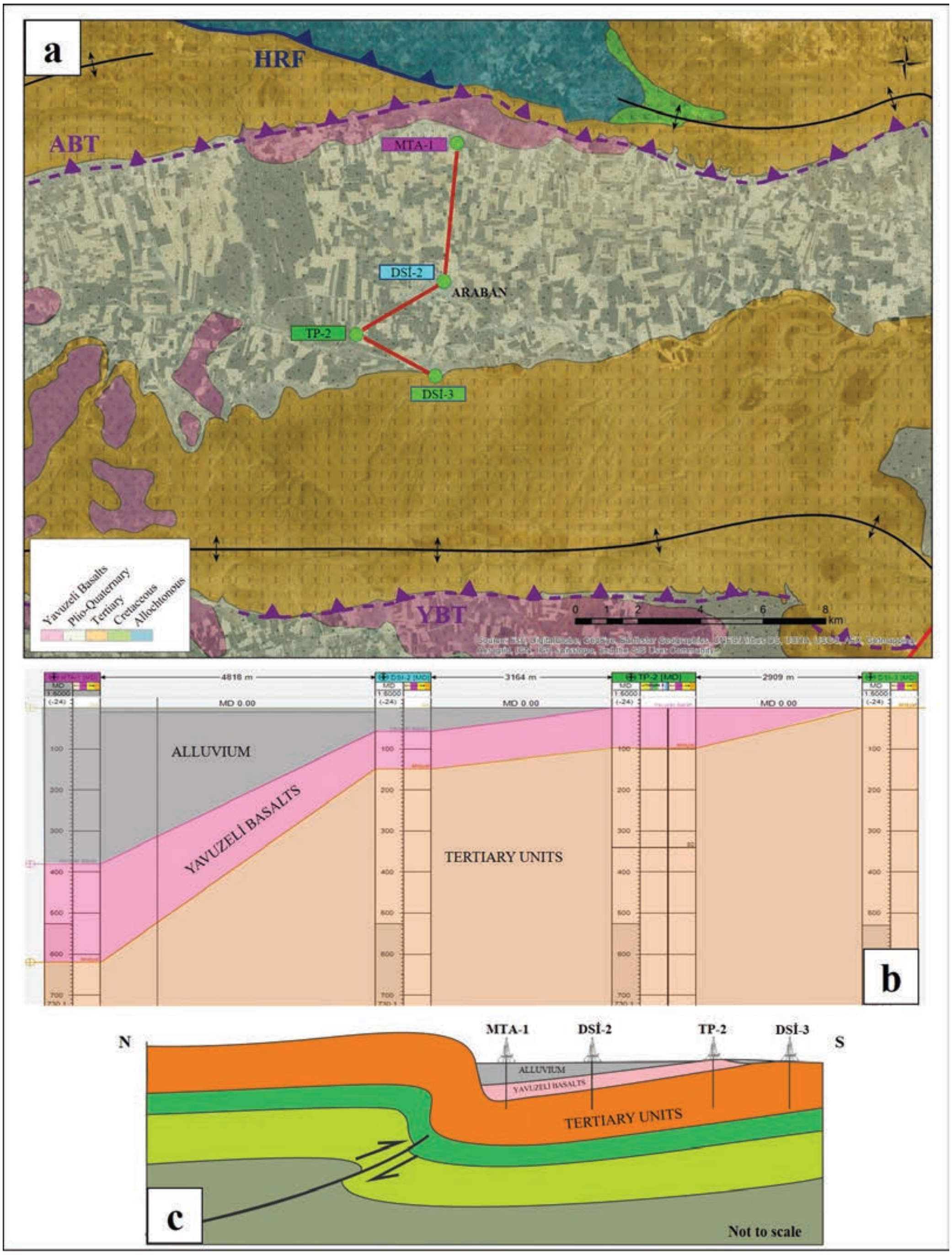


Figure 5- **(a)** Geologic map showing the drilling locations excavated in the Araban Plain by TPAO, MTA and DSI (State Water Works) for different purposes. **HRF:** Harmancık Fault, **ABT:** Araban Blind Thrust, **YBT:** Yavuzeli Blind Thrust, **(b)** N-S directing correlations of the wells MTA-1, DSI-2, TP-2 and DSI-3 excavated in the Araban Plain, **(c)** N-S directing schematic cross section passing through the Araban Plain.

the blind thrusts, which restrict plains from north control the deposition of the Quaternary alluvium and these thrusts, could be active structures. On the road cut between the Kuyulu and Karapınar, the shear zone cleavages, which developed on the segment reaching the surface, the section above the hanging block in the eastern continuation of the Araban blind thrust, show that this movement belongs to reverse faulting (Figures 6a, b, c). The structural data above the fault plane observed in the stone quarry in north of the Akdere village also verify this fact (Figures 6a, d, e).

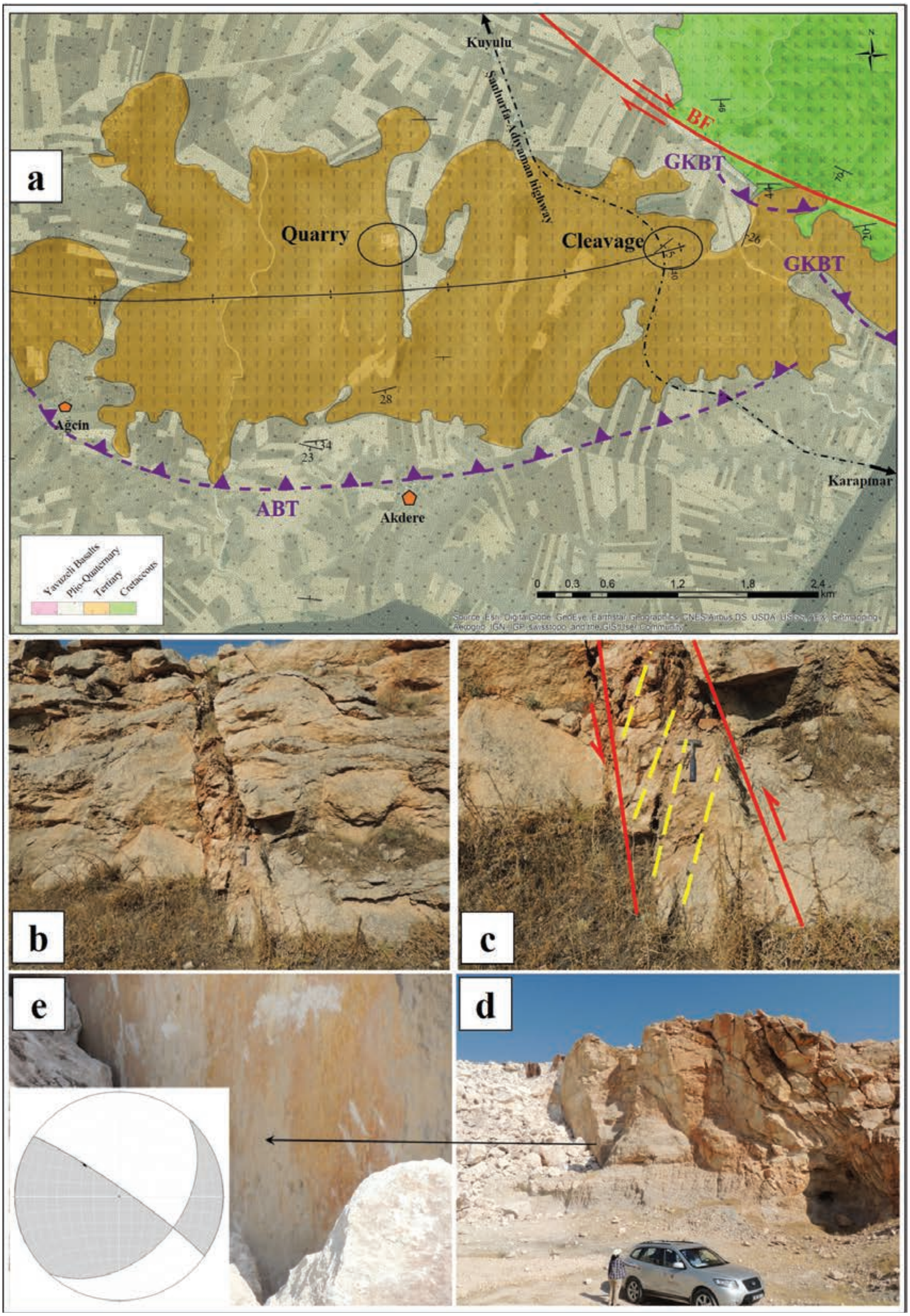


Figure 6- **(a)** Geological map of north of the Akdere village. **BF:** Bozova Fault, **ABT:** Araban Blind Thrust, **GKBT**: Gemrik-Karababa Blind Thrust, **(b)** shearing cleavages within the fault zone cutting the limestones of the Eocene Midyat Group, **(c)** the hanging wall should have moved upward -reverse fault- according to the position of the shear cleavage developed parallel to the S1 axis of the strain ellipse, **(d)** the plane of a different reverse fault in the stone quarry located in north of the Akdere village, **(e)** close up view of the fault surface and the equal area lower hemisphere stereographical projection formed by the striations measured on the fault plane.

### 3.2. Gemrik-Karababa Blind Thrust

Çemen et al. (1990), also by benefiting from the previous studies, defined Gemrik, Karababa and Dutluca anticlines, and stated that the fold axes were in NW-SE directions and their axial planes dipped towards NE by taking measurements from the fold limbs.

The field studies and remote sensing analyses carried out also showed that these anticlines were asymmetrical and the layers in the southern limbs were at high angle. Furthermore; there were also detected overturned layers inside the main valley in the NW of the Durak village (Figures 7a, b, e). As it can be anticipated from the deformed layers of the Şelmo Formation, the Gemrik-Karababa-Dutluca anticlines should have formed in post-Pliocene time.

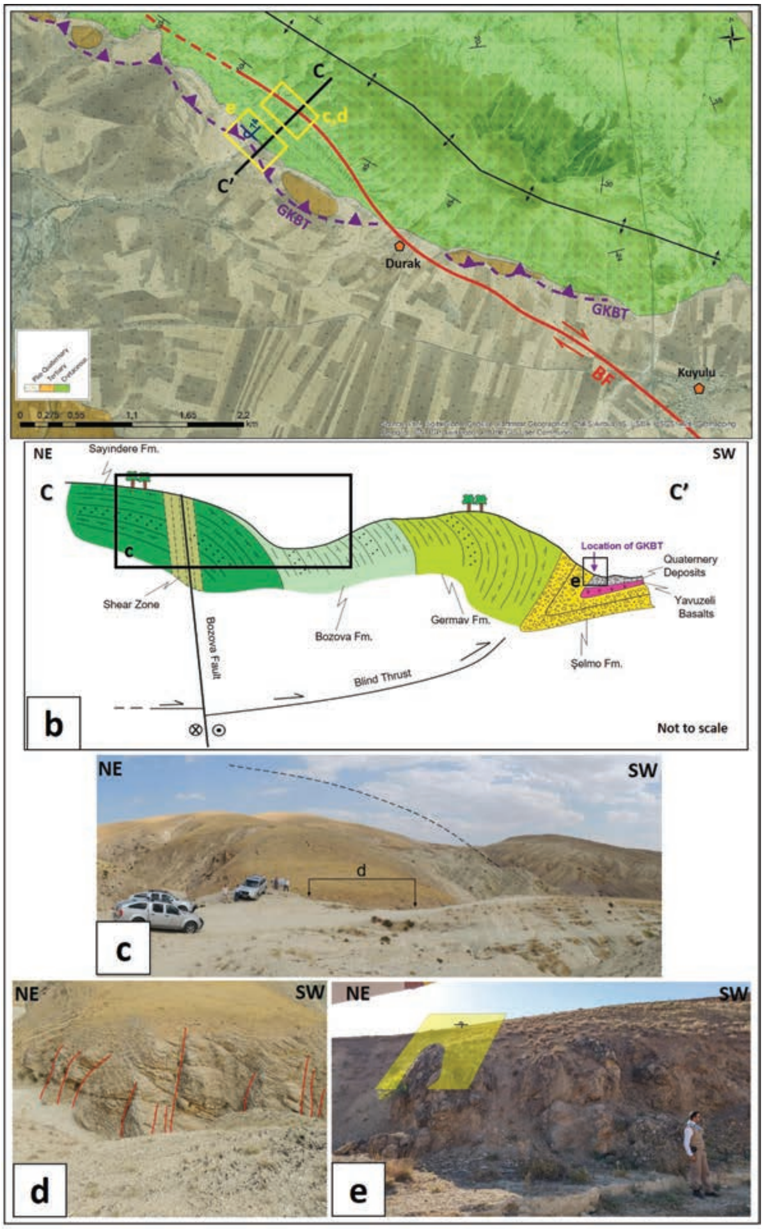


Figure 7- **(a)** Geological map of the Gemrik Anticline surround. **BF**: Bozova Fault, **GKBT:** Gemrik-Karababa Blind Thrust, **(b)** geological cross section prepared along the C-C' profile, **(c)** field view of the Gemrik Anticline, **(d)** shear zone of the Bozova Fault which cuts the Gemrik Anticline, **(e)** overturned layers which formed in the Pliocene Şelmo formation with the effect of the Gemrik-Karababa Blind Thrust.

All these data allow the Gemrik-Karababa-Dutluca anticlines to be interpreted as the fault propagation folds, which developed on the hanging wall of the blind thrusts, and the Gemrik-Karababa Blind Thrust to be drawn at the end of steeply dipping S-SW limbs of the asymmetrical anticlines (Figures 8a, b). The Gemrik-Karababa Blind Thrust and the Araban Blind Thrust approach each other in the north of the Karapınar village (Figure 8a).

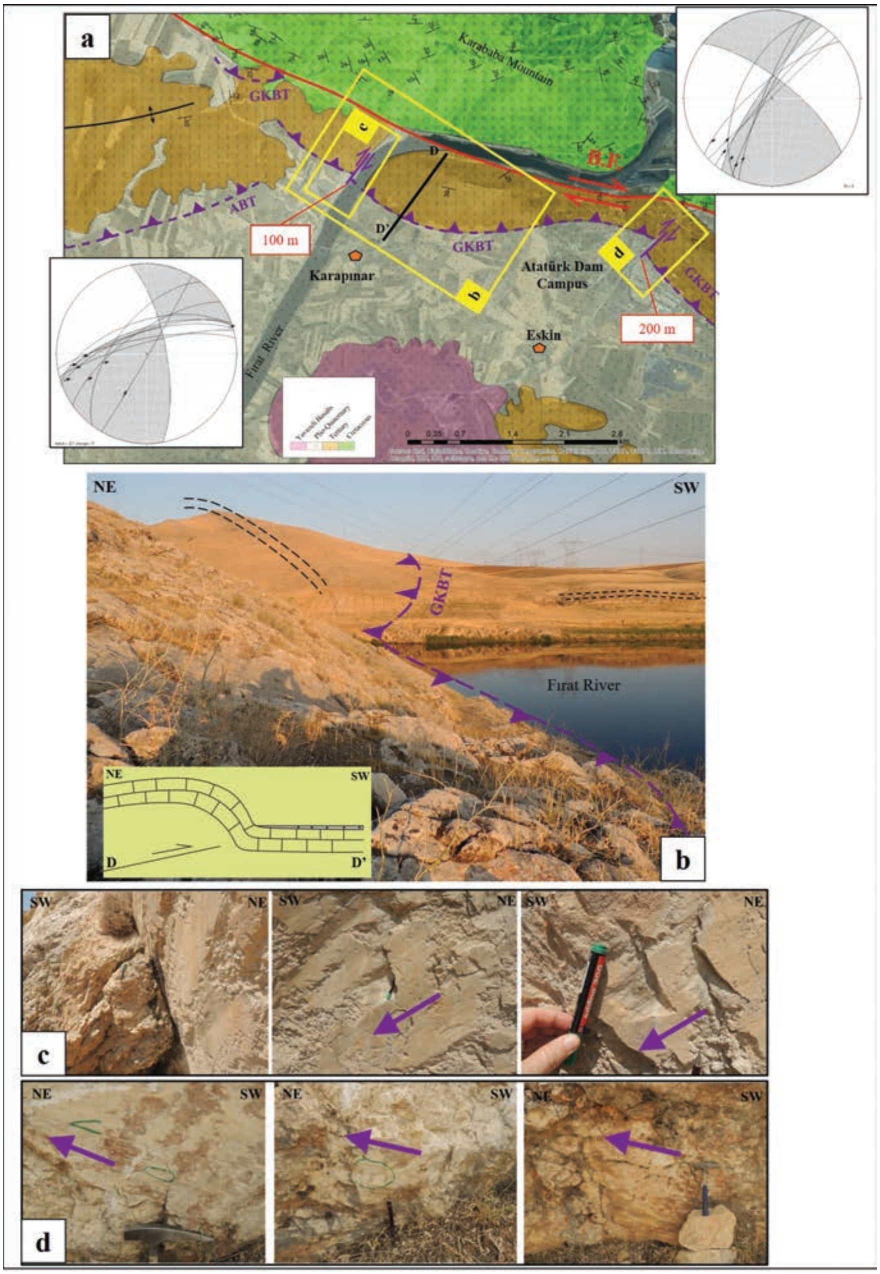


Figure 8- **(a)** Geological map belonging to the Atatürk Dam vicinity and the equal area lower hemisphere stereographical projection formed by the data measured on the fault plane of tear faults offsetting the blind thrust line which was drawn to the front of the steeply dipping beds of the asymmetrical Gemrik-Karababa anticline. **BF:** Bozova Fault, **GKBT**: Gemrik-Karababa Blind Thrust, **(b)** view from the northern limb of the Karababa asymmetrical anticline and its schematic relationship with the probable blind thrust, **(c)** views of the structures (striations, carrot structures and slickensides) belonging to the tear faults located near the Fırat River, the south of the Atatürk Dam discharge area, **(d)** striations of the tear fault at the tunnel exit located in the northwest of the Atatürk Dam settlement (Purple arrows show the movement direction of the missing block).

On section, where the Fırat (Euphrates) River erodes the Karababa anticline and at the tunnel exit around the Atatürk Dam settlement, the Gemrik-Karababa Blind Thrust has been shifted nearly 100-200 meters by the NE-SW trending right lateral strike-slip tear faults. The structural data regarding them is presented in figures 8a, c and d.

### 3.3. Halfeti Fault

The Halfeti Fault, is a NE-SW trending strike-slip fault which extends between Yarımtepe in the north and the Sarılar village in the south. It was first mapped by Peksü (1976) and defined by Çemen (1986) as the Kemerli Fault. It was emphasized by Çemen (1990) that the fault shifted the Suvarlı anticline 500 meters leftward and was conjugate of the Bozova Fault.

The northeastern extension of the Halfeti Fault passes through the western side of the Yarım Tepe (hill) from the traceable southeast end of the Gemrik-Karababa and Çakırhüyük Blind Thrusts (north of Beşyol) (Figure 9a). It is well observed in the north of Halfeti, in NE-SW directions between the east of the Sarılar village and the northwest of the Fıstıklıdağ village. It directly limits the Yavuzeli and Araban plains and shifts the Suvarlı anticline laterally 2.5 km to the left. The E-W directed flow of the Fırat River between the Atatürk Dam and the Halfeti Fault returns to NE-SW direction with the effect of the fault in the southwest of the Fıstıklıdağ village and flows along the fault zone (Figure 9a).

The structural data obtained from the northeast and southwest parts of the Halfeti Fault show that

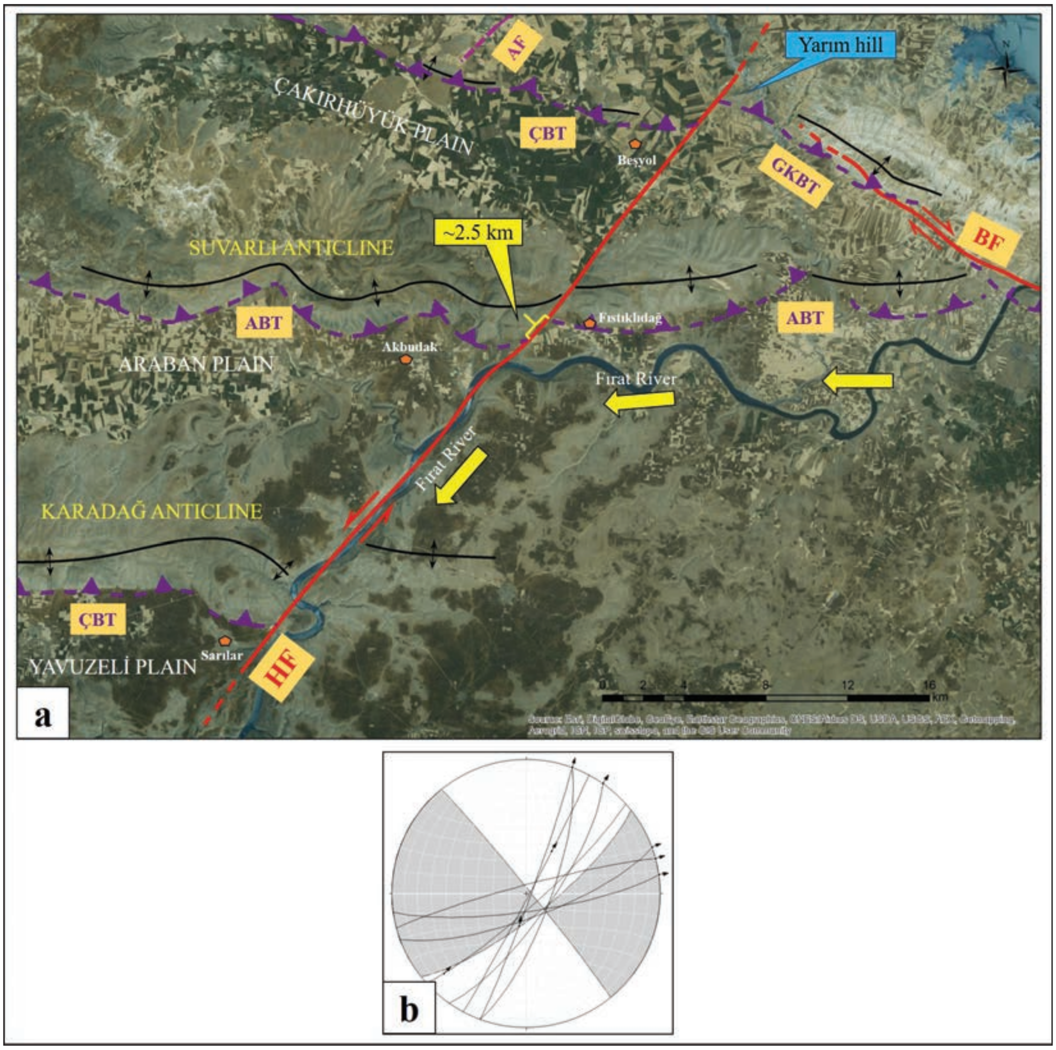


Figure 9- **(a)** NE-SW trending Halfeti Fault and surrounding structures. Yellow arrows indicate the flow direction of the Fırat River controlled by the Halfeti Fault. **HF**: Halfeti Fault, **BF**: Bozova Fault, **ABT**: Araban Blind Thrust, ÇBT: Çakırhüyük Blind Thrust, **GKBT**: Gemrik-Karababa Blind Thrust, **(b)** the equal area lower hemisphere stereographical projection formed according to the striations measured on the planes of the Halfeti Fault.

this structure is the left lateral strike-slip in character (Figure 9b). The Halfeti Fault should be one of the youngest faults that was formed in Quaternary in the region as it cuts the anticlines associated with the Gemrik-Karababa and Araban blind thrusts which developed in the post Pliocene.

### 3.4. Bozova Fault

First studies regarding the Bozova Fault began in 1960's. It was made by the American Overseas Petroleum Limited and the Bozova Fault was described as the high angle reverse fault. Sungurlu (1972) defined the Bozova Fault, which had uplifted the region starting from Permian to Cretaceous. He also stated that the fault had controlled the deposition in the region in Coniacian-Santonian times, then reworked as normal fault in the Miocene time.

Çemen et al. (1990) defined the Bozova Fault, which had been previously described as a strike-slip fault with reverse component in the maps made by Perinçek et al. (1987), as the right lateral strike-slip fault. They also emphasized that the first reverse movement on the Bozova Fault had occurred in the Oligocene, then moved as a strike-slip fault in the Late Miocene or Early Pliocene times. In the same study, the folds around Bozova Fault were examined and stated that the fold axes of Gemrik, Karababa and Dutluca anticlines in the northeastern block of fault are nearly parallel to the Bozova Fault showing no genetic relationship between folds and Bozova Faults. However, the open folds having axes of northeast-southwest in the southwestern block of the fault were attributed to the Bozova Fault (Çemen et al., 1990).

The NW-SE extending Bozova Fault, which is also shown in the active faults of the General Directorate of Mineral Research and Exploration (MTA) (Duman et al., 2012), is distinctively followed starting from the Durak village in the northwest until the Küçük Tülmen village in the southeast (Figure 10a). The NE-SW trending thrust faults, which developed as segments separating from the Bozova Fault, are observed in Arıkök, NW of Bozova and around the Küçük Tülmen village.

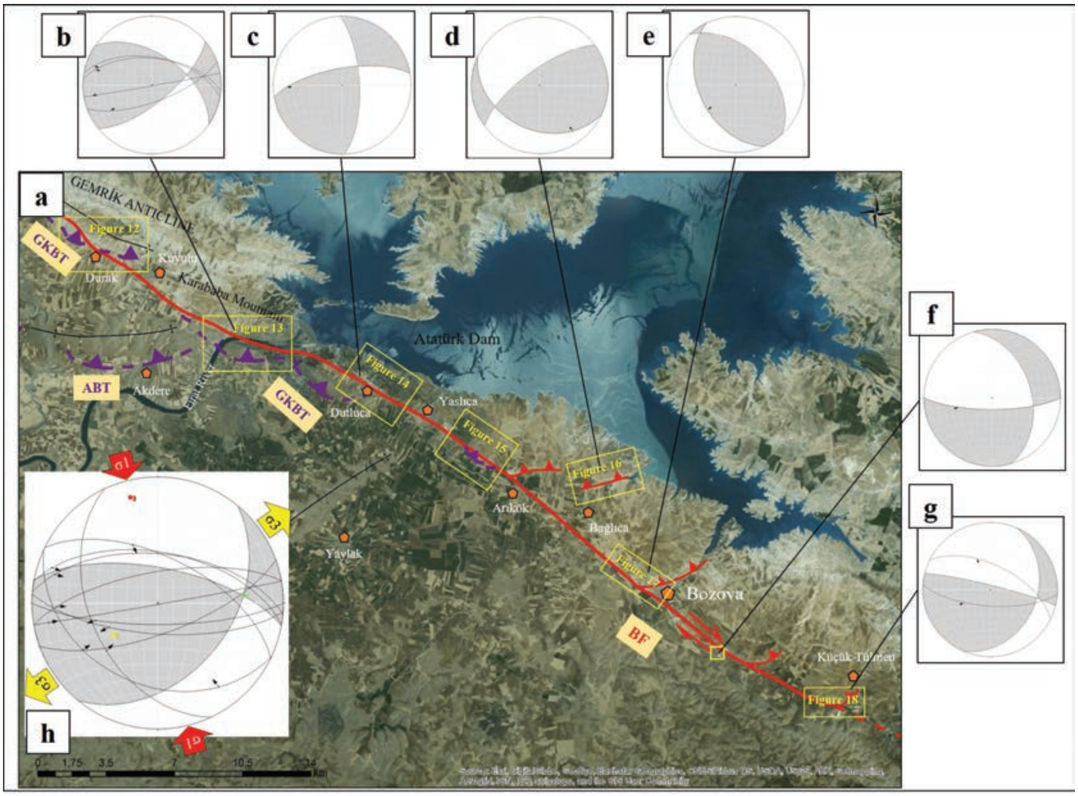


Figure 10- **(a)** General view of the Bozova Fault, **BF:** Bozova Fault, **GKBT:** Gemrik-Karababa Blind Thrust, **ABT**: Araban Blind Thrust. The equal area lower hemisphere stereographical projection formed by the structural data measured on the fault planes located in; **(b)** the east of the Atatürk Dam, **(c)** the north of the Dutluca village, **(d)** the northeast of the Bağlıca village, **(e)** the northwest of the Bozova town, **(f)** the southeast of the Bozova town, **(g)** the vicinity of the Küçük Tülmen village, **(h)** the equal area lower hemisphere stereographical projection and stress directions formed by the total assessment of the structural data measured on the Bozova Fault.

The data belonging to the northwest end of the Bozova Fault is seen in shear zones cutting the Karababa anticline (Figures 7 and 10). One of the most significant geomorphological data are the warps in the northwest of the Durak village, along the river flowing towards the southeast observed both on field studies and on Google Earth images (Figure 11).

The fault passes through the Durak village, cuts the Gemrik-Karababa Blind Thrust and reaches the Kuyulu village. This fault, which cuts again the Karababa Blind Thrust in the southwest of the Kuyulu village, is seen in such a way to cut the Karababa Mountain anticline as being parallel to its axis. The Fırat River should be chasing this line just in front

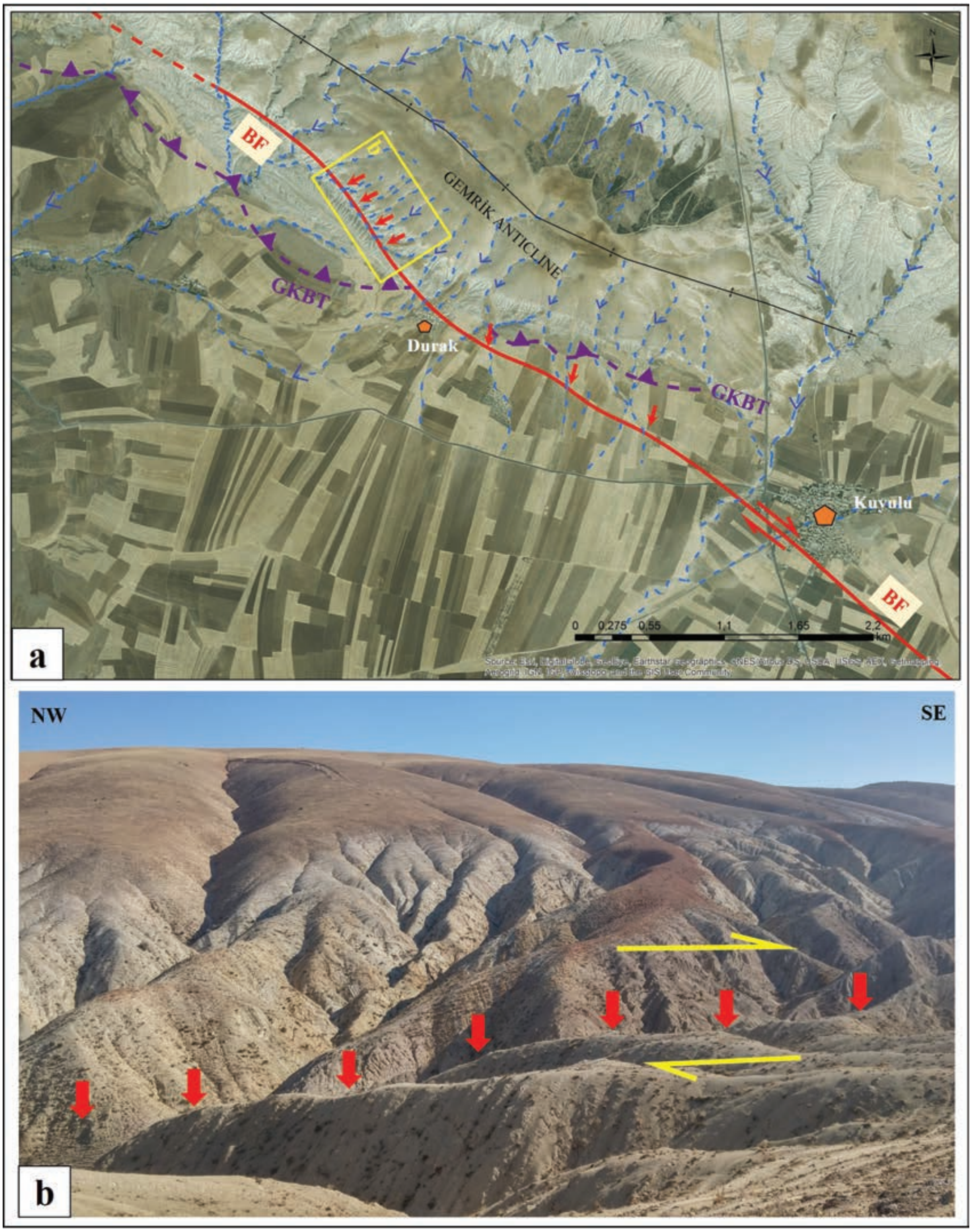


Figure 11- **(a)** The map showing the distortions that formed in stream channels by the effect of the Bozova Fault, the north of the Durak village, **(b)** the field view (red arrows indicate where the Bozova Fault passes through). **BF:** Bozova Fault, **GKBT:** Gemrik-Karababa Blind Thrust.

of the Atatürk Dam (Figure 12). The fault cuts the Gemrik-Karababa Blind Thrust and the Dutluca anticline as being parallel to the its axis just in north of Dutluca passing through the southern part of the Atatürk Dam, then it reaches the Arıkök village via Yaslıca. In the area, which remains between the Atatürk Dam and the Dutluca village, there are observed slip surfaces and shearing developed under the effect of fault in the Sayındere formation (Figure 13). The Gemrik-Karababa Blind Thrust is cut again in the northwest of Arıkök. The limb of the anticline located on the hanging wall of this thrust is clearly cut, and this situation is distinctively observed both on the field and in Google Earth images (Figure 14).

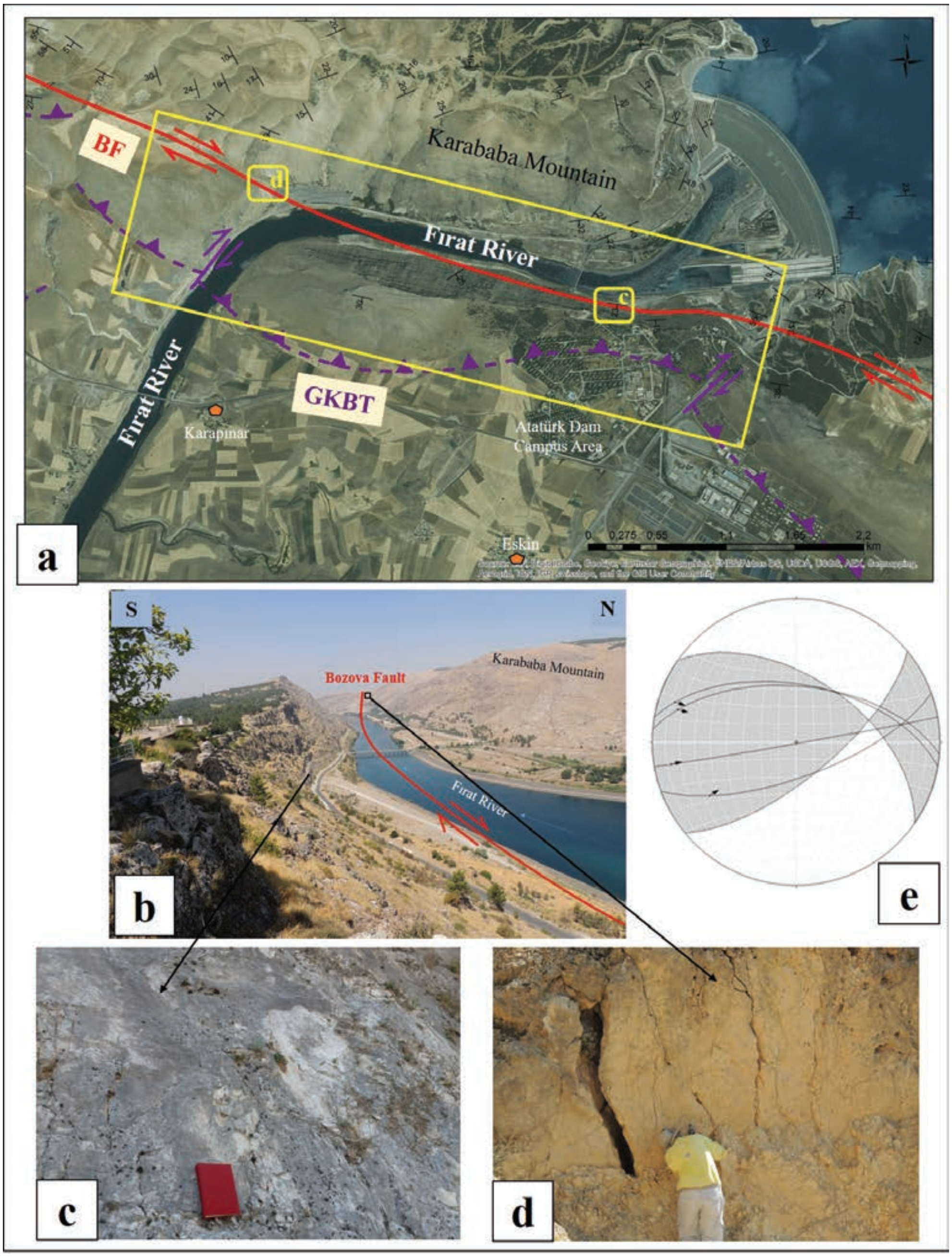


Figure 12- **(a)** Map showing the re-direction of the NW-SE extending Fırat River by the effect of the Bozova Fault. Yellow squares indicate the locations of photos in c and d. **BF:** Bozova Fault, **GKBT:** Gemrik-Karababa Blind Thrust, **(b)** photo showing the extension of the Bozova Fault along the Fırat River, **(c)** the fault plane located on the southern block of the Bozova Fault, **(d)** the fault plane located on the northern block of the Bozova Fault, **(e)** the equal area lower hemisphere stereographical projection formed by the structural data measured on fault planes.

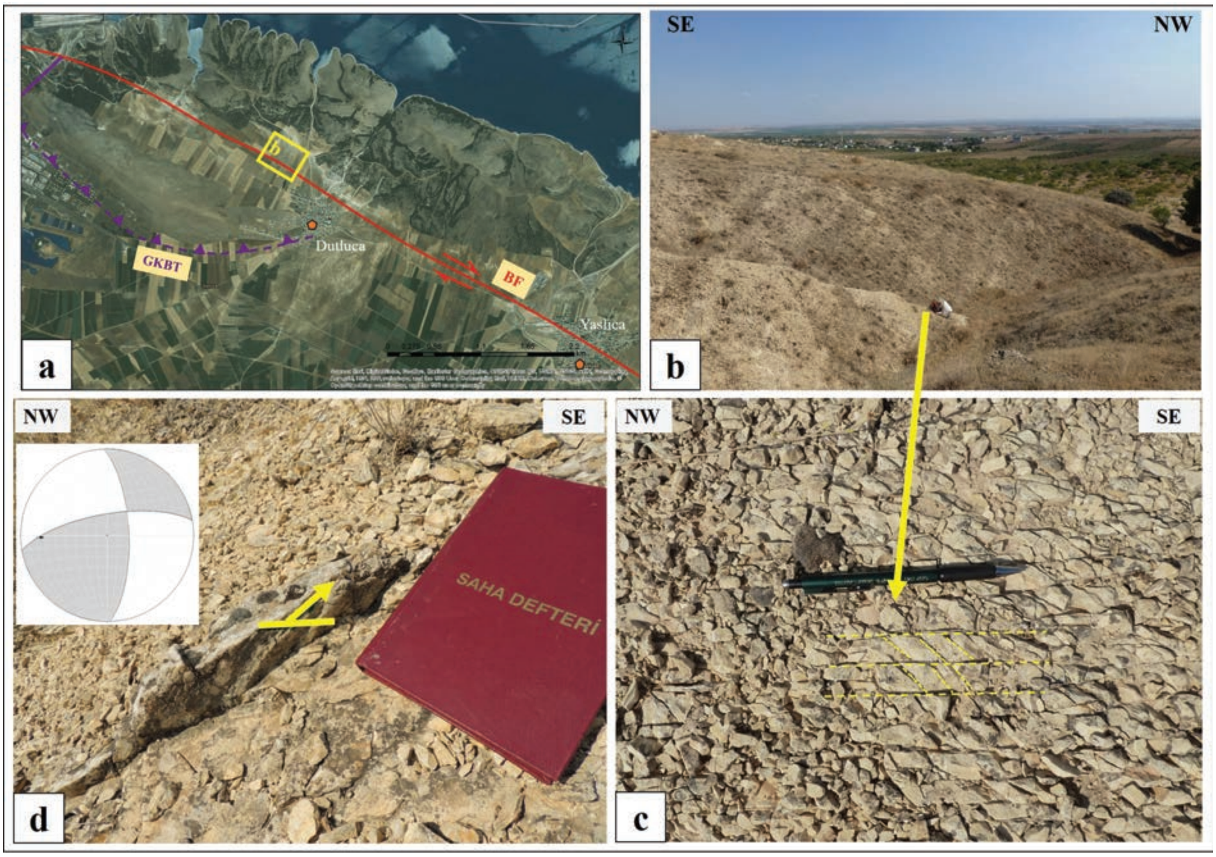


Figure 13- **(a)** Map showing the extension of the Bozova Fault in north of the Dutluca village, **GKBT:** Gemrik-Karababa Blind Thrust, **(b)** the shear zone formed in the Sayındere formation by the effect of the Bozova Fault, **(c)** joint systems developed in the Sayındere formation due to the Bozova Fault, **(d)** the striations of the Bozova Fault in the Sayındere formation and the equal area lower hemisphere stereographical projection made with this measurement.

As it is mentioned above, the Bozova Fault cuts the formerly developed Gemrik-Karababa Blind Thrust in many places and the tear faults mentioned in Figure 8, which are associated with this thrust, are kinematically unconformable.

The topography is undulated in the north of the Bağlıca village and the layers belonging to the Sayındere formation in this area form an asymmetrical anticline of which its one limb reaches 90°. This situation verifies the presence of thrusts of the Bozova Fault drawn by Duman et al. (2012) (Figure 15).

The Bozova Fault runs parallel to the Şanlıurfa-Adıyaman road between Arıkök and Bozova (Figure 10a). There are observed a color change and fragility due to the hydrothermal activity in the limestones of the Sayındere formation just in the northwest of the Bozova town (Figures 16a, b, c). The layers of the Sayındere formation just in the north of the Bozova town to gain a dip of 40° in S-SW direction could be the indicator of a thrust development as well as in the east of Arıkök (figure 16a).

In the southeast of the Bozova settlement, the structural data showing the right lateral movement of the Bozova Fault, which runs parallel to the Adıyaman-Şanlıurfa road, can be seen in stones quarries excavated along the road sides. It becomes difficult to follow the Bozova Fault after it makes a curvature towards the Küçük Tülmen village, and there is not any morphological evidence showing that it continues towards the southeast (Figure 17).

The total assessment (Figure 10h) of the structural data collected from the Bozova Fault (Figures 12-17), shows that the fault in the northwest end and in the middle part is right lateral strike-slip with thrust component and dips towards the northeast. The focal mechanism solutions of the earthquakes occurring in the southeastern end of the Bozova Fault, where it is connected to the Akçakale-Harran Graben in the region

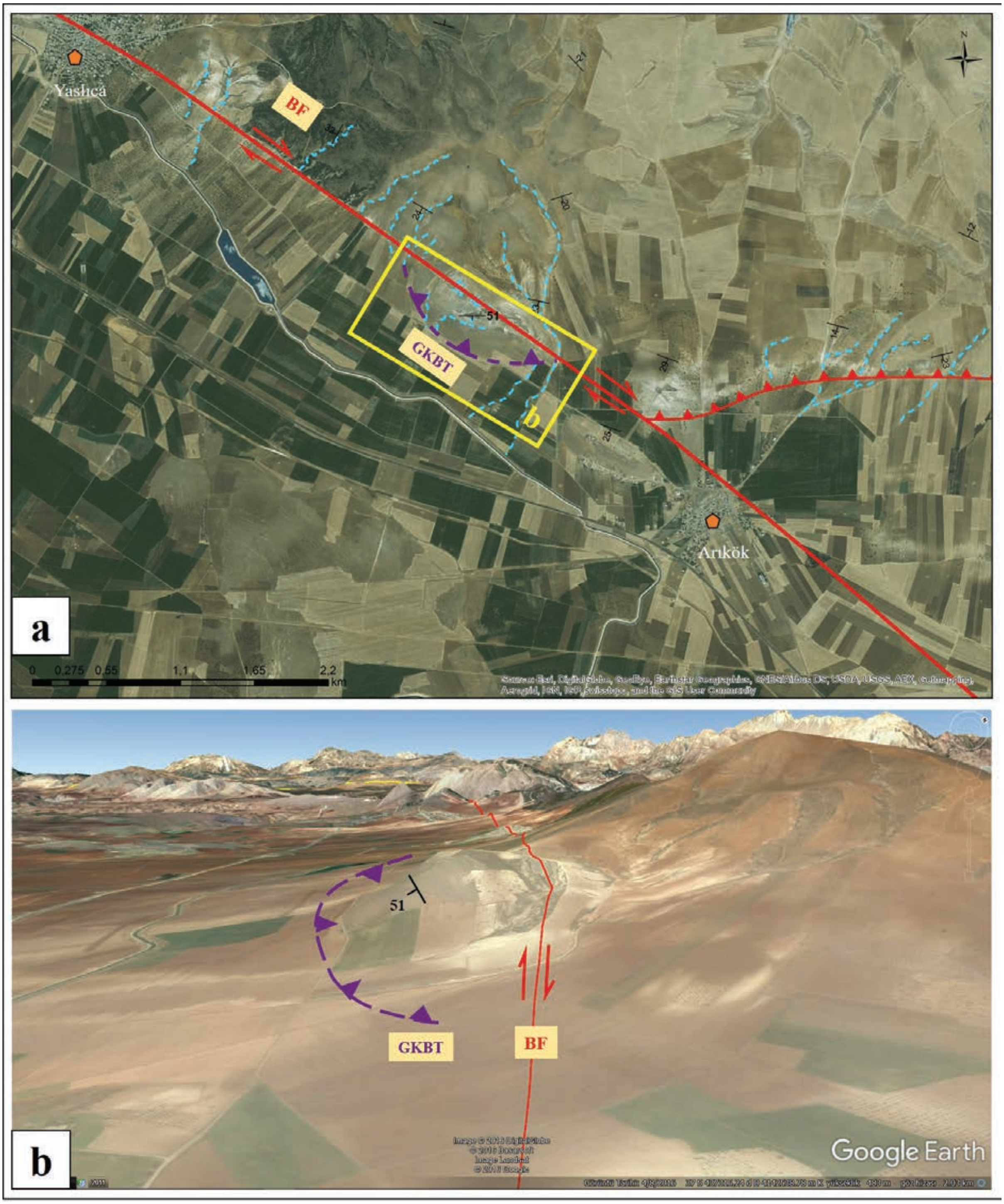


Figure 14- **(a)** Map showing the cross cutting of the Gemrik-Karababa Blind Thrust by the Bozova Fault in northwest of the Arıkök village, **GKBT**: Gemrik-Karababa Blind Thrust, **(b)** the anticline limb cut by the Bozova Fault on the hanging wall of the Gemrik-Karababa Blind Thrust (looking north).

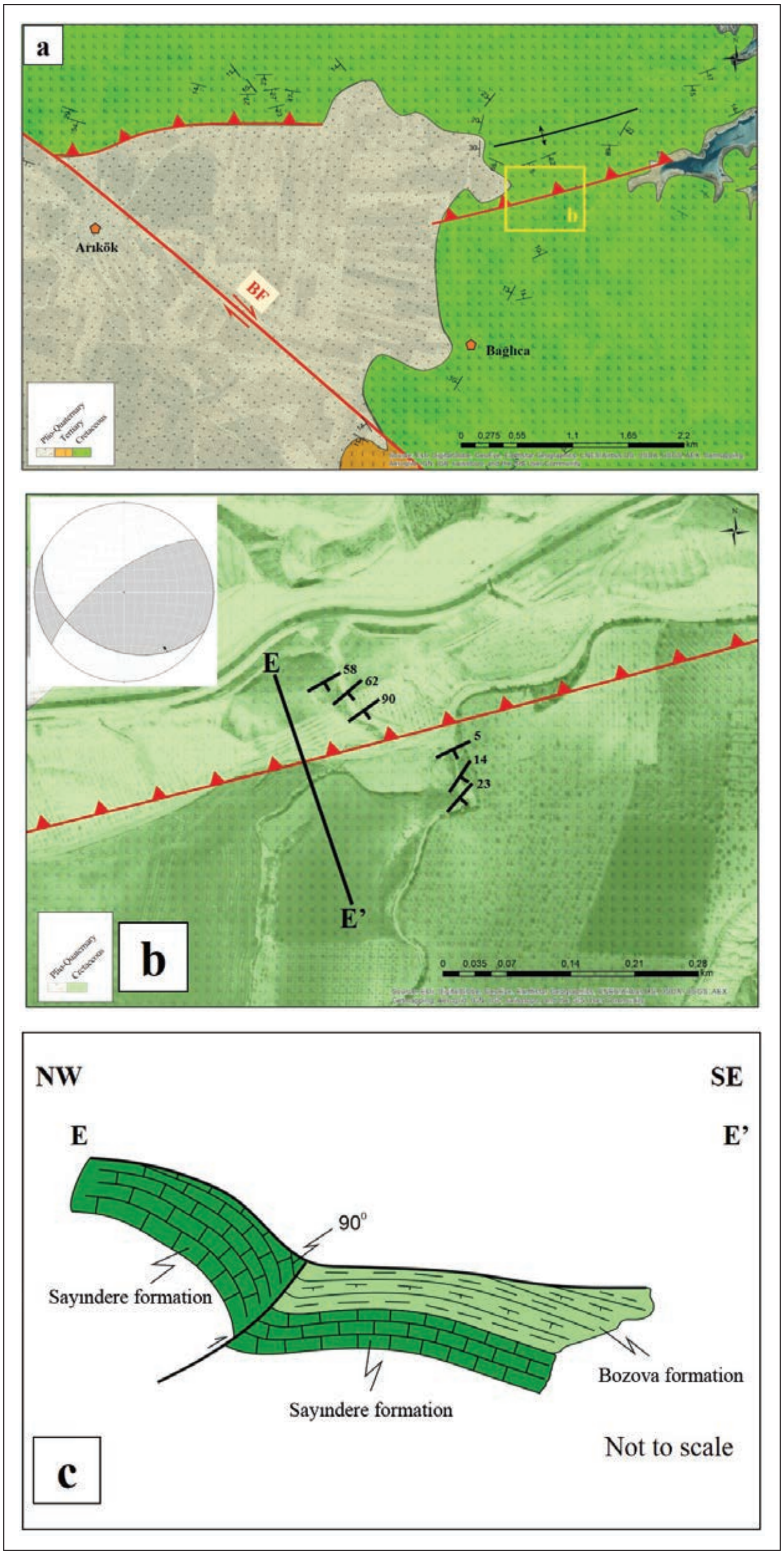


Figure 15- **(a)** Geological map showing the thrust segments of the Bozova Fault around the Bağlıca village. **BF:** Bozova Fault, **(b)** geological map showing the dip change developed in layers of the Sayındere Formation by the effect of the thrust fault located in northeast of the Bağlıca village and the equal area lower hemisphere stereographical projection formed by the structural data measured on this fault, **(c)** geological cross section of the profile E-E'.

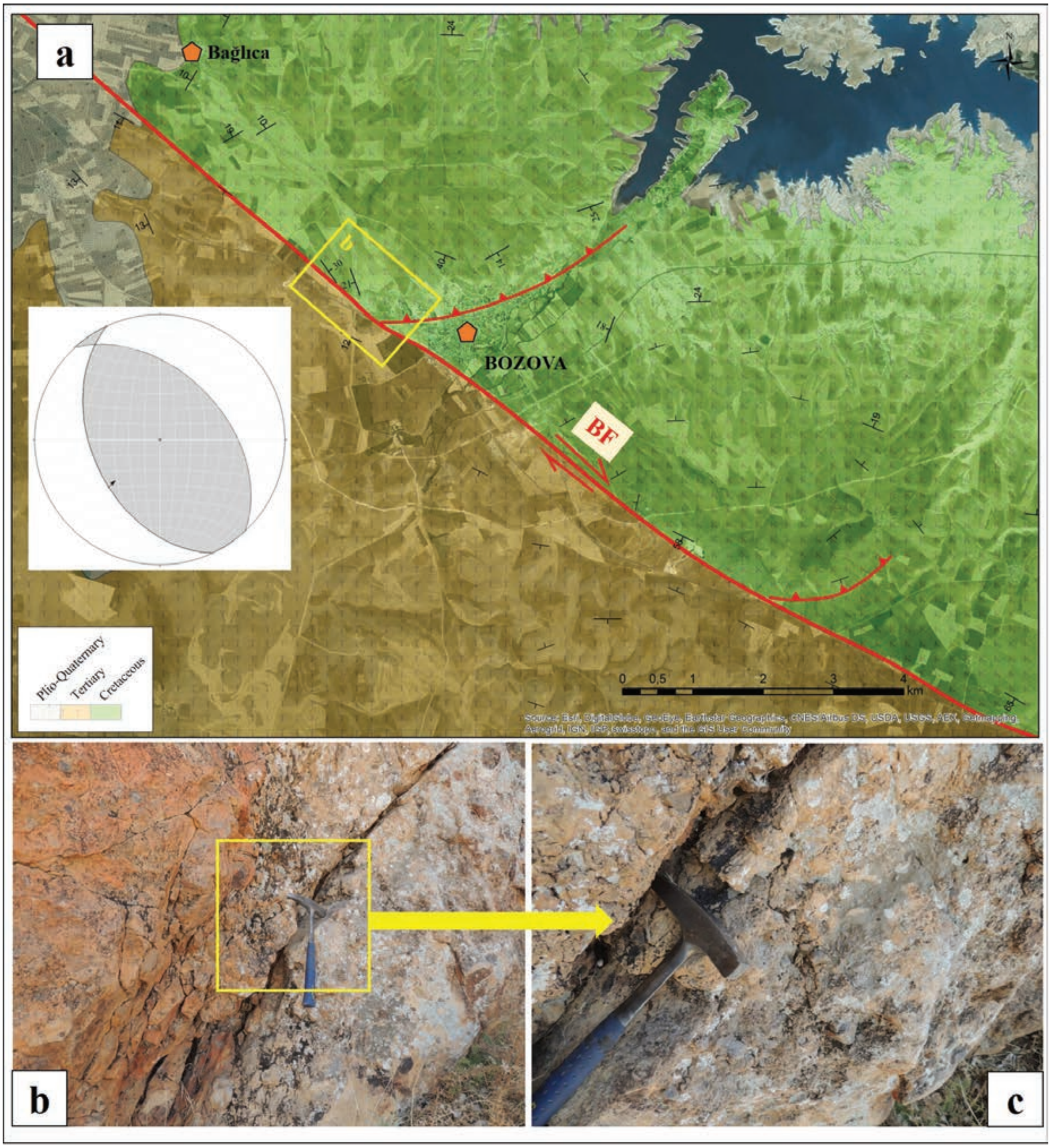


Figure 16- **(a)** Geological map showing the location of the Bozova Fault in north of the Bozova town and the equal area lower hemisphere stereographic projection formed by the structural data measured on the thrust segment separating from the fault, **BF:** Bozova Fault, **(b)** and **(c)** photos showing the color change and cataclastic zone that formed by the hydrothermal activity in the Sayındere formation.

(Kartal et al., 2011; Seyitoğlu et al., 2017), states that the Bozova Fault evolved into a right lateral fault with normal component, dipping southwest and has an helicoidal geometry (Figure 18). The seismic activity, which has recently occurred in the region (2017.03.02 Samsat earthquake, M=5.5), revealed the presence of a segment that runs sub parallel to the Bozova Fault, trending in NW-SE direction, with the southeast end approaching to the Bozova Fault (Figure 18). The depth distribution of the seismic activity, which occurs on this segment and the northeastward dipping plane shown in the focal mechanism solution of the USGS, are seen in compatible with each other (Figure 19). It is theoretically anticipated that the strike-slip fault segments are connected to one shearing zone at depth (Naylor et al., 1986).

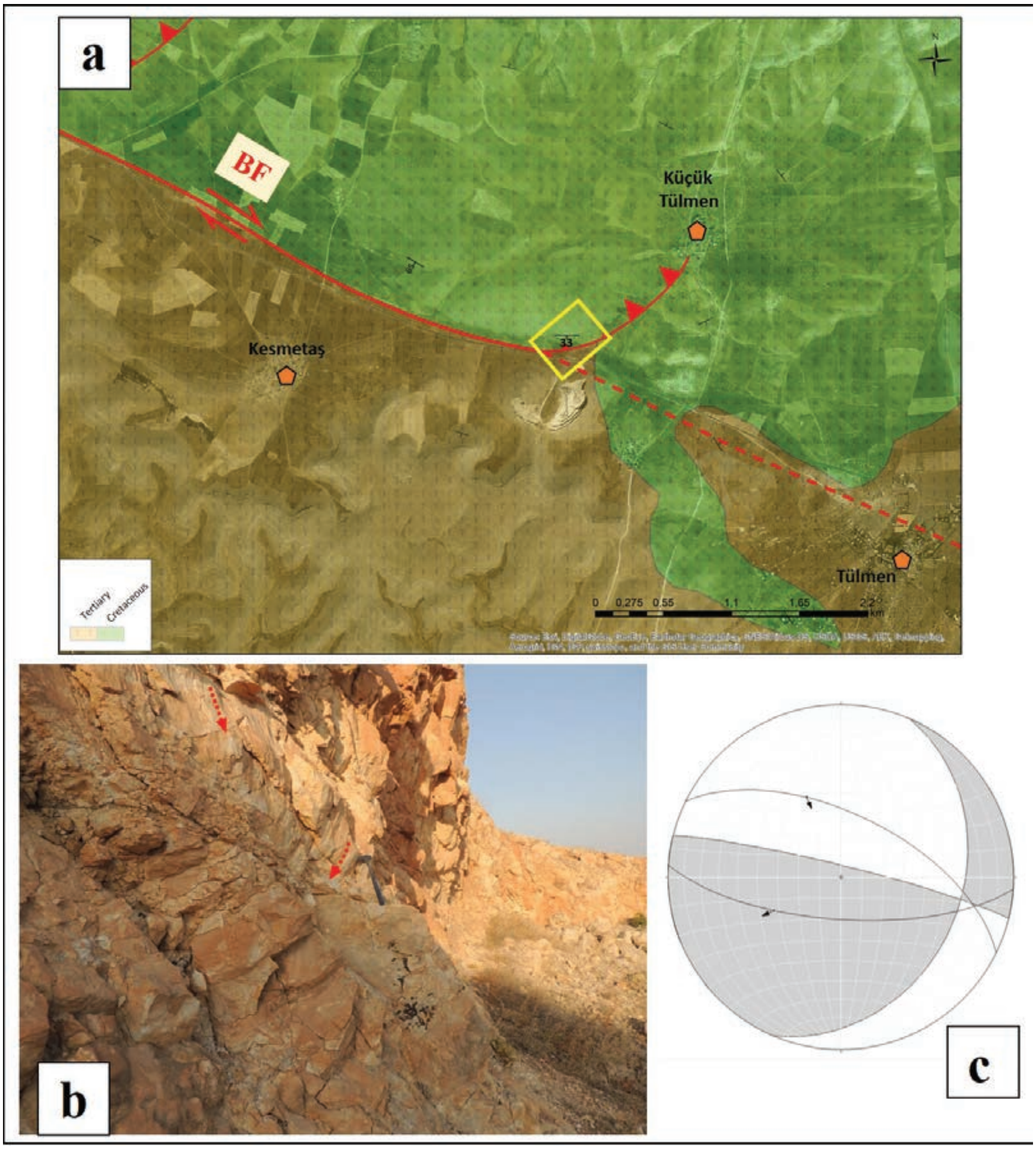


Figure 17- **(a)** Geological map of the Küçük Tülmen village surround where the Bozova Fault is last observed morphologically, **BF:** Bozova Fault, **(b)** view from the striations of the fault surface, **(c)** the equal area lower hemisphere stereographical projection formed by the data measured of the fault plane.

## 4. Discussion and Results

The E-W trending thrust faults, the NW-SE right lateral strike-slip faults and the NE-SW left lateral strike-slip faults which are the typical neotectonic structures of the Southeastern Anatolia, are all located in the NE Gaziantep. The thrust faults in the area were defined as blind thrusts by means of the fault propagation folds developed on hanging walls of the faults (e.g. Çakırhüyük, Araban, Yavuzeli Blind Thrusts and Gemrik-Karababa Blind Thrusts). The presence of the Şelmo Formation, which folded in the Gemrek-Karababa anticline, shows that the blind thrusts in the study area developed in the post Pliocene. The Araban Blind Thrust and the Gemrik-Karababa Blind Thrust are distinctively cut by the left lateral Halfeti Fault and by the right lateral Bozova Fault, and they are the youngest structures. However, these relationships do not show that the E-W trending blind thrusts are not active, because the blind thrust associated recent earthquakes [2011.10.23 Van earthquake - M=7.3: Doğan and Karakaş (2013); Elliot et al., (2013); 2012.06.14 - ML=5.5 Şırnak-Silopi earthquake: Seyitoğlu et al., 2017)] developed in the Eastern and Southeastern Anatolia show that the blind thrusts too have a potential to generate earthquakes and actively compensate the regional N-S contraction like the strike-slip faults.

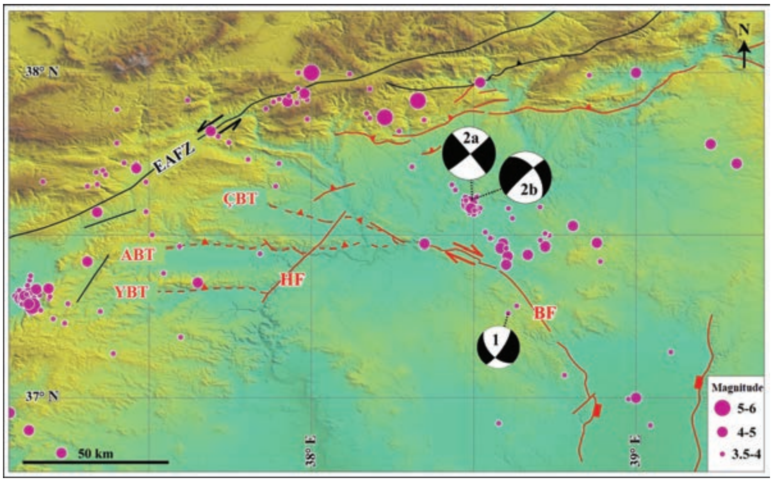


Figure 18- The seismic activity around the Bozova Fault (data belong to AFAD and include earthquakes from 1990-recent with M≥3.5). The focal mechanism solution of the 2015.11.10 (M=3.6) earthquake (1) (Seyitoğlu et al., 2017); 2017.03.02 (M=5.5) the focal mechanism solution of Samsat earthquake (2a AFAD, 2b USGS). **ÇBT**: Çakırhüyük Blind Thrust, **ABT**: Araban Blind Thrust, **YBT**: Yavuzeli Blind Thrust, **HF**: Halfeti Fault, **BF**: Bozova Fault.

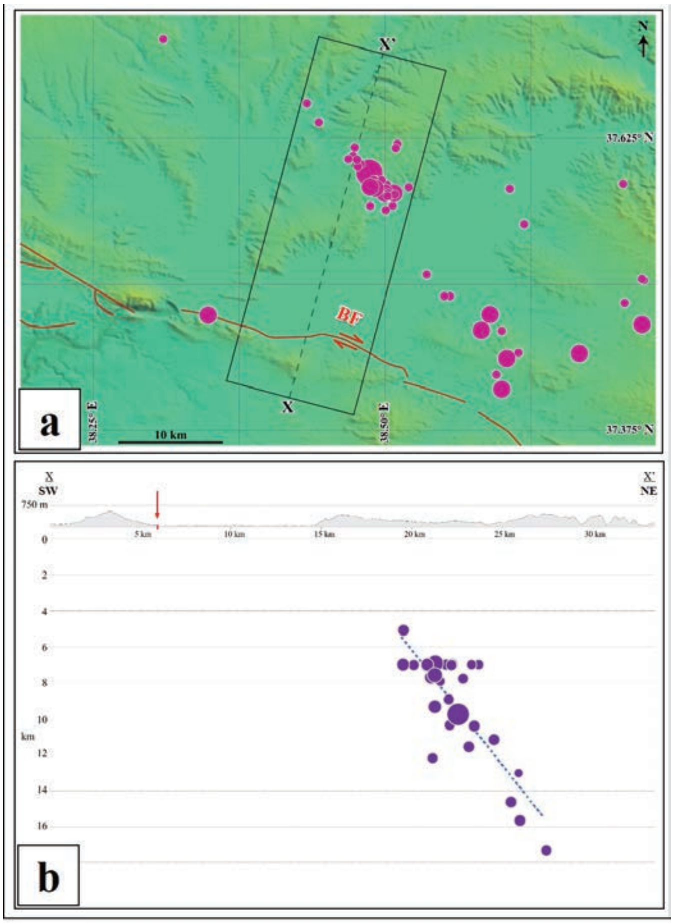


Figure 19- **(a)** The epicenter and depth distribution of the seismic activity around the Bozova Fault. The rectangle area shows the data used in the depth distribution, **(b)** topographical section is 5 times exaggerated and red arrow shows the trace of the Bozova Fault on the surface. The dashed blue line represents the fault dip in the USGS focal mechanism solution.

**Acknowledgements**

This article is produced from the MSc thesis, which is about to be completed by the first author in Ankara University. Due to the facilities provided in the field studies authors would like to thank Turkish Petroleum Co. We are thankful to Dr. Korhan Esat for his supports for the earthquake data, and to invaluable referees, to Prof. Erdinç Yiğitbaş, Assoc. Prof. Ali Farzipour-Saein, Assist. Prof. Hakan Güneyli and to Dr. Selim Özalp for their critiques and suggestions in developing this article.

**References**

Açıkbaş, D., Sungurlu, O., Akgül, A., Erdoğan, T.,1979. Geology and petroleum possibilities of Southeast Turkey. TPAO report no: 1410

Açıkbaş, D., Akgül, A., Erdoğan, L. T. 1981. Güneydoğu Anadolu'nun hidrokarbon olanakları ve Baykan-Şirvan-Pervari yöresinin jeolojisi. TPAO report no: 1543.

American Overseas Petroleum Limited. 1960. Geological report on the SAF-Bozova trend- License no:8. TPAO report no: 765

Agard, P., Omrani, J., Jolivet, L., Whitechurch, H., Vrielynck, B., Spakman, W., Monie, P., Meyer, B., Wortel, R. 2011. Zagros orogeny: a subduction-dominated process. Geol Mag 148, 692-725.

Batı, Z. 1991. X. Bölge kuzeyinin Miyosen palinostratigrafisi. TPAO report no: 1683.

Berberian, M. 1995. Master "blind" thrust faults hidden under the Zagros folds: active basement tectonics and surface morphotectonics. Tectonophysics 241, 193-224

Biddle, K.T., Bultman, T.R., Fairchild, L.H., Yılmaz, P.O. 1987. An approach to structural interpretation of the southeast Turkey fold and thrust belt. Proceedings of 7$^{th}$ Biannual Petroleum Congress of Turkey. UCTEA Chamber of Petroleum Engineers, 78-88.

Bolgi, T. 1961. V. Petrol Bölgesi seksiyon ölçmeleri AR/TPO/261 nolu saha ile Reşan-Dodan arası batısındaki sahanın striktüel etüdleri. TPAO report no: 162.

Çemen, İ. 1986. Structural geology of the western part of the Araban tectonic block implications concerning petroleum potential of the region. TPAO report no: 2239.

Çemen, İ. 1990. Araban Tektonik Bloğu Doğu Kısmının Yapısal Jeolojisi ve Petrol Potansiyeli. TPAO report no: 2727.

Çemen, İ., Perinçek, D., Ediger, Ş. V., Akça, L. 1990. Güneydoğu Anadolu'daki Bozova doğrultu atımlı Fault: üzerindeki ilk hareket ters faylanma olan faylara bir örnek. Türkiye 8. Petrol Kongresi, 169-179.

Çoruh, T. 1991. Adıyaman civarında (XI. Bölge kuzeybatısı ve XII. Bölge ) yüzeyleyen Kampaniyen-Tanesiyen istifinin biyostratigrafisi ve paleocoğrafik evrimi. TPAO report no: 1656.

Dewey, J.F. Hempton, M.R., Kidd, W.S.F., Şaroğlu. F., Şengör. A.M.C. 1986. Shortening of continental lithosphere: the neotectonics of Eastern Anatolia a young collision zone. In: Coward M P, Ries A C, editors. Collision Tectonics. Geol Soc Lond Spec Publ: 19, 3-36 (Robert M. Shackleton volume).

Doğan, B., Karakaş, A. 2013. Geometry of co-seismic surface ruptures and tectonic meaning of the 23 October 2011 Mw 7.1 Van earthquake (East Anatolian Region, Turkey). J Struc Geol: 46, 99-114.

Duman, T.Y. Emre, Ö., Olgun, Ş., Özalp, S., 2012. 1:250.000 Scale Active Fault Map Series of Turkey, Cizre (NJ38-9) Quadrangle. Serial number: 53, General Directorate of Mineral Research and Exploration, Ankara-Turkey.

Duran, O., Şemşir, D., Sezgin, İ. Perinçek D. 1988. Güneydoğu Anadolu'da Midyat ve Silvan Gruplarının Stratigrafisi, Sedimantolojisi ve Petrol Potansiyeli. TPJD Bulletin. 2, 99 -126.

Duran, O., Şemşir, D., Sezgin, İ. Perinçek D. 1989. Güneydoğu Anadolu'da Midyat ve Silvan Gruplarının stratigrafisi, sedimantolojisi ve paleocoğrafyası, paleontolojisi, jeoloji tarihi, rezervuar ve diyajenez özellikleri ve olası petrol potansiyeli. TPAO report no: 2563.

Elliot, J. R. Copley, A. C., Holley, R., Scharer, K., Parsons, B., 2013. The 2011 Mw 7.1 Van (Eastern Turkey) earthquake. Journal of Geophysical Research, Solid Earth, 118, 1-19.

Emre, Ö., Duman, T.Y., Özalp, S., Elmacı, H., Olgun, Ş., Şaroğlu, F., 2013. Active fault map of Turkey with an explanatory text 1:1,250,000 scale. Special Publication Series 30, General Directorate of Mineral Research and Exploration, Ankara, Turkey. ISBN: 978- 605-5310-56-1.

Ercan, T. Fujitani, T., 1990. Doğu ve Güneydoğu Anadolu Neojen-Kuvaterner Volkanitlerine İlişkin Yeni

Jeokimyasal, Radyometrik ve İzotopik Verilerin Yorumu. Bulletin of Mineral Research and Exploration 110, 143-164.

Erenler, M., 1989. XI-XII. Bölge güney alanlarındaki kuyularda Mesozoyik çökel istifinin mikro paleontolojik incelenmesi. TPAO report no: 1364.

Farzipour-Saein, A., Yassaghi, A., Sherkati, S., Koyi, H. 2009. Mechanical stratigraphy and folding style of the Lurestan region in the Zagros Fold - Thrust belt, Iran. Journal of the Geological Society, London 166, 1101-1115.

Gossage, D. W. 1956. Compiled progress report on the geology of part of Petroleum District VI, Southeast Turkey: N. V. Turkse Shell. Report no. GRT. 2, 22 p.

Görür, N., Çelikdemir, E., Dülger, S. 1987. Güneydoğu Anadolu X, XI. ve XII. Petrol Bölgelerinde Mardin Grubu Karbonatlarının Sedimantolojisi: Yayılım, fasiyes, çökelme ortamı ve paleocoğrafya. TPAO report no: 2321

Güven, A., Dinçer, A., Tuna, M. E., Çoruh, T. 1991, Güneydoğu Anadolu Kampaniyen-Paleosen otokton istifinin stratigrafisi, TPAO report no: 2828.

Hall, J.K., Krasheninnikov, VA., Hirsch, F., Benjamini, C., Flexer, A. 2005. Geological Framework of the Levant. Volume II: The Levantine basin and Israel. Historical Productions-Hall, Jerusalem, Israel. ISBN: 965-7297-03-6.

Haq, B.U. Hardenbol, J., Vaıl, R.P. 1988. Mesozoic and Cenozoic chronostratigraphy and cycles of sea level change. Society of Economic Paleontologists and Mineralogists Special Publication 42, 71-108

Hatzfeld, D., Authemayou, C., Van Der Beek, P., Bellier, O., Lave, J., Oveisi, B., Tatar, M., Tavakoli, F., Walpersdorf, A., Yamini-Fard, F. 2010. The kinematics of the Zagros Mountains (Iran). In: Leturmy P, Robin C, editors. Tectonic and Stratigraphic Evolution of Zagros and Makran during the Mesozoic–Cenozoic. Geol Soc Lond Spec Publ 330: 19–42. DOI: 10.1144/SP330.3.

Joudaki, M., Farzipour-Saein, A., Nilfouroushan, F. 2016. Kinematics and surface pattern of the Anaran basement fault zone in NW of the Zagros fold-thrust belt. International Journal of Earth Sciences 105, 869-883.

Kartal, R. F., Zünbül, S., Kadirioğlu, F. T. 2011. Atatürk Barajı Havzasının Depremselliği. 15. ATAG Workshop

Krasheninnikov, V.A., Hall, J.K., Hirsch, F., Benjamini, C., Flexer, A., 2005. Geological Framework of the Levant. Volume I: Cyprus and Syria. Historical Productions-Hall, Jerusalem, Israel. ISBN: 965-7297-02-8.

Lisenbee, A.L. 1986. Structural Studies of Selected Areas in Southeast Anatolia. TPAO report no: 2229

Lisenbee, A.L. 1987. Report of investgiation tectonic analysis of the Adıyaman to Harzo region-southeast Anatolia-(with notes on the Harran graben Bozova trend). TPAO report no: 2236

Maxson, J. H., 1936. Geology and petroleum possibilities of the Hermis dome. Directorate of Mineral Research and Exploration Compilation no: 255. 25 s.

Naylor, M.A., Mandl, G., Sijpesteijn, C.H.K. 1986. Fault geometries in basement-induced wrench faulting under different initial stress states. Journal of Structural Geology 8, 737–752.

Okay, A.I. 2008. Geology of Turkey: a synopsis. Anschnitt 21, 19-42.

Öğrenmiş, İ.Y. 2006. Şelmo Formasyonu'nun Kahta (Adıyaman) kuzeyindeki yüzeylemelerinde sedimantolojik incelemeler, Yüksek Lisans Tezi. Fırat Üniversitesi. 55 s. (unpublished)

Peksü, M. 1976. M40c, M40d, N39a, N39b, N40a, N40b, 1/50000 ölçekli jeoloji haritaları. TPAO arşivi (Compilation).

Perinçek, D. 1978. V-VI-IX. Bölge (Güneydoğu Anadolu otokton-allokton birimler) jeoloji sembolleri. TPAO report no: 6657.

Perinçek, D. 1979. Hazro, Korudağ-Çüngüş, Maden, Hazar, Elazığ, Malatya dolayının jeolojisi. TPAO report no: 1395

Perinçek, D. Günay, Y., Kozlu, H., 1987. New observations on strike-slip faults in east and southeast Anatolia. Proceedings of 7th Biannual Petroleum Congress of Turkey. UCTEA Chamber of Petroleum Engineers, 89-103.

Perinçek, D. Ve Çemen, İ. 1991. Late Cretaseous-Paleogene structural evoluation of the structural highs of Southern Anatolia. Ozan Sungurlu Symposium Notifications. 386-403

Rigo De Righi, M., and Cortesini, A. 1964. Gravity tectonics in foothills structure belt of Southeast Turkey. Am. Assoc. Pet. Geol. Bull. 48, 1911-1937.

Robertson, A., Boulton S.J., Taslı, K., Yıldırım, N., İnan, N., Yıldız, A., Parlak, O. 2016. Late Cretaceous - Miocene sedimentary development of the Arabian continental margin in SE Turkey (Adıyaman region): Implications for regional palaeogeography and the closure history of Southern Neotethys. J Asian Earth Sci 115, 571-616

Schmidt, K. 1935a. First report over geological and paleontological: Directorate of Mineral Research and Exploration Compilation no: 1532

Sefunç, A. 2003. Adıyaman, Bozova, Kızılin, Harmancık ve Kemerli faylarının sismik verilerle tanımı. TPAO report no: 4430

Seyitoğlu, G., Esat, K., Kaypak, B. 2017. The neotectonics of southeast Turkey, northern Syria, and Iraq: the internal structure of the Southeast Anatolian Wedge and its relationship with recent earthquakes. Turkish Journal of Earth Sciences 26, 105-126.

Sungurlu, O. 1972. VI. Bölge Gölbaşı-Gerger arasındaki sahanın jeolojisi, TPAO report no: 802

Sungurlu, O. 1974. VI. Bölge kuzey sahalarının jeolojisi, Türkiye 2. Petrol Kongresi, 85-108.

Şaroğlu, F., Emre, Ö., Kuşçu, İ. 1992. Active Fault Map of Turkey. Directorate of Mineral Research and Exploration Publication.

Şemşir, D., Duran, O., Alaygut, D., Kaya, M.A., Kumsal, K., Güngör, H., ve Aydemir, V. 1992. XI–XII. bölgelerde Beşikli, Doğu Beşikli, Tokaris, Bakacak sahalarıyla İkizce-Taşlık kuyuları civarının stratigrafisi, tektoniği, yeraltı jeolojisi ile Karaboğaz Fm ve Mardin Grubunun sedimantolojoisi, diyajenezi elektrofasiyes analizi ve rezervuar değerlendirmesi, TPAO report no: 3051

Şengör, A.M.C., Görür, N., Şaroğlu, F. 1985. Strike-slip deformation basin formation and sedimentation: Strike-slip faulting and related basin formation in zones of tectonic escape: Turkey as a case study. In: Biddle KT, Christie-Blick N, editors. Strike-slip faulting and basin formation. Soc Econ Paleontol Min Spec Publ 37, 227-264.

Şengör, A.M.C., Özeren, M.S., Keskin, M., Sakınç, M., Özbakır, A.D., Kayan, İ. 2008. Eastern Turkish high plateau as a small Turkic-type orogen: Implications for post-collisional crust-forming processes in Turkic-type orogens. Earth-Sci Rev 90, 1-48.

Tolun, N., 1960. Stratigraphy and tectonics of Southeastern Anatolia. Révue de la Faculté des Sciences de l'Université D'İstanbul, Tome XXV, Fasc. 3-4, série B, 204-264 p.

TPAO, 2014. Map Archive (Anonymous). Ankara, Türkiye.

Tromp, S. W. 1940. Preliminary report on the oil possibilities of S.E. Turkey, based on a re-interpretation of microfaunal and sub-surface data (Cenubu Şarki Türkiye'nin stratigrafisi, strüktür vecleri ve petrol imkanları ile bunların mücavir mıntıkalarla mukayesesi). Directorate of Mineral Research and Exploration Compilation no: 1216. 74 s.

Tuna, D. 1973. VI. Bölge litostratigrafi birimleri adlamasının açıklayıcı raporu. TPAO report no: 813.

Ulu, Ü. 2002. 1:500.000 Ölçekli Türkiye Jeoloji Haritası Hatay Paftası. Türkiye 1/500.000 Ölçekli Jeoloji Haritaları, No: 16, M. Şenel (Ed.), Maden Tetkik ve Arama Genel Müdürlüğü, Ankara.

Yılmaz, Y. 1984. Amanos dağlarının jeolojisi. TPAO report no: 1920 .

Yılmaz, Y. 1990. Allochthonous terranes in the Tethyan Middle East Anatolia and the surrounding regions. Phil. Trans. Royal Society of London, A331, 611-624.

Yılmaz, Y. 1993. New evidence and model on the evolution of the southeast Anatolian orogen. Geol Soc Am Bull 105, 251-271.

Yılmaz, Y., Yiğitbaş, E. 1990. SE Anadolu'nun farklı ofiyolitik –metamorfik birlikleri ve bunların jeolojik evrimdeki rolü. Türkiye 8. Petrol kongresi, Jeoloji Bildirileri, s. 128-140.

Yiğitbaş, E., Yılmaz, Y. 1996. New evidence and solution to the Maden complex controversy of the Southeast Anatolian orogenic belt (Turkey). Geol Rundsc 85, 250–263.

Yoldemir, O. 1985. Suvarlı (Adıyaman) yakın dolayının jeolojisi: TPAO report no: 2113.

Yoldemir, O. 1987. Suvarlı-Haydarlı-Narlı Gaziantep arasında kalan alanın jeolojisi, yapısal durumu ve petrol olanakları: TPAO report no: 2257.

Yoldemir, O., Akça, L., Şengündüz, N., Gürgey, A., Turan, M., Güngör, H., Aydemir, V. 1992. Araban-Suvarlı sahalarının stratigrafik, tektonik ve rezervuar değerlendirmesi: TPAO report no: 3114.

Yoldemir, O., Sefunç. A. 1999. Kemerli, Burç ve Batı Bozova alanının jeoloji, jeofizik ve hidrokarbon potansiyelini değerlendirme ve belirlenen prospekt alanlar. TPAO report no: 2113.