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Syn-sedimentary tectonic markings in the Oligocene Datça-Kale-Acı Göl basin, Western Anatolia

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Research Article

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ABSTRACT

In southwest Turkey, the Oligocene sedimentary sequence is located on the Datça-Kale-Acı Göl basin between the Menderes Massif and Lycian nappes. To understand the nature of this basin is important for tectonic models that explain the exhumation of the Menderes massif. In the northeast extension of this basin, the sedimentary sequence is interpreted as alluvial fan, fan-delta, beach, marine input, inner shelf carbonates and offshore deposits. The Oligocene Datça-Kale main breakaway fault bounding the south eastern margin of the basin is represented by İnceler and Acı Göl faults in the study area. The wedge geometry of the sequence thickening towards the İnceler normal fault is an evidence of syn-tectonic deposition. The northwest margin of the basin is controlled by two en-echelon faults. The sedimentary sequence has a wedge geometry thickening towards the normal fault and at the same time its upper layers overlap the fault. As a result, the northeast extension of the Datça-Kale-Acı Göl Oligocene basin is an elongated fjord like depositional area containing the shallow marine environments controlled by normal faults located in its southeast and northwest margins. It was demonstrated that the southeast basin margin limited by the Datça- Kale main breakaway fault performed dominant tectonic control. The similar kinematic indicators that is used for the model explaining the exhumation of the Menderes massif by the upward bending of Datça-Kale main breakaway fault are also observed in the northwest of the basin as top to the north-northeast.

1. Introduction

The Datça-Kale-Acı Göl Oligocene basin is located between the Menderes massif and the Lycian nappes in southwestern Anatolia and has a northeast-southwest extension (Figure 1). The outcrops of Oligocene basin units in the region can be traced from the Gökova Gulf to Kale and from the northeast of Denizli to Dinar area, and have been studied in the literature giving different basin names (eg. Lycian molasse basin, Kale basin, Kale-Tavas basin, Çardak-Tokça basin, Çardak-Dazkırı basin, Denizli basin) (Figure 1). It was interpreted that Datça-Kale-Acı Göl basin was developed on the hanging wall block of the Datça-Kale main breakaway fault, which is associated with the exhumation as an asymmetric core complex of the Menderes massif (Seyitoğlu et al., 2004).

The outcrops belonging to Oligocene sedimentary units were mapped in the north of the Gökova Bay (Gürer and Yılmaz, 2002). The Datça fault located in the south of the bay in the submarine seismic reflection studies carried out in the Gulf of Gökova, is seen in listric normal fault geometry dipping northward (Kurt et al., 1999). The seismic reflection sections obtained along the hanging wall block of the fault and perpendicular to the Datça fault reveal the presence of a sedimentary sequence which is 2500 m thick and

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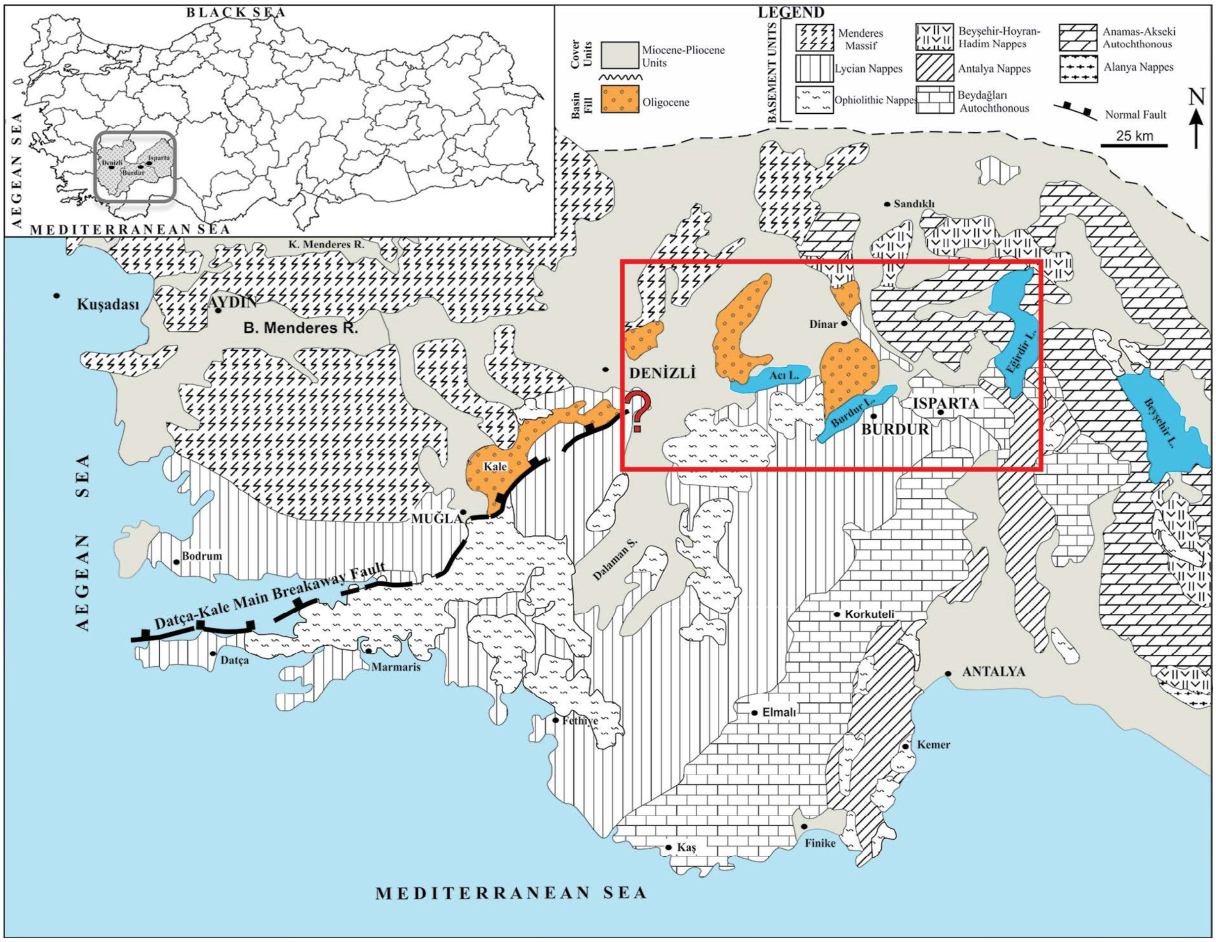

Figure 1- Study area in the northeast of Datça-Kale-Acı Göl basin in southwestern Anatolia (Datça-Kale main breakaway fault from Seyitoğlu et al. (2004), regional geology from Konak, 2002; Turhan, 2002; Konak and Şenel, 2002; Şenel, 2002).

thickens towards the fault with a wedge geometry (Kurt et al., 1999, see line 11). The sediment thickness and its geometry show that basin units here were deposited as syn-sedimentary in the control of the Datça fault and it was interpreted that this deposition occurred in the Oligocene period (Seyitoğlu et al., 2004). The data related to continuation of faulting observed in the submarine in the Gökova Bay and associated formations on land in the east were shown by the geophysical data by Çağlar and Duvarcı (2001).

The Kale section of the northeastern most of the Datça-Kale-Acı Göl basin was studied by Hakyemez (1989) and Yılmaz et al. (2000). Yılmaz et al. (2000) and Gürer and Yılmaz (2002) stated that the Kale-Tavas basin was developed under the control of northeast - southwest trending normal faults dipping northwest. They interpreted this basin as a “piggy-back” basin which developed on the Lycian nappes and also suggested that it had been developed under tectonic regime representing a contraction in north-south directions in general.

The Oligocene successions in Denizli and Çardak-Dazkırı basins in the northeast together with Kale-Tavas basins were investigated by Sözbilir (2005). Suggesting that these basins were formed by the southward detachment of the Lycian nappes over the Menderes massive under the extensional tectonic regime, it was stated that folds observed in basin fills were related with the rootless movement of the Lycian nappes towards the south. Although not explicitly stated in the text, it is understood that Sözbilir (2005) agrees with the “Lycian detachment fault” associated with the first exhumation of Menderes massif in the symmetrical core complex model of Ring et al. (2003). Sözbilir (2005) in his study explained the reported observation of the basement rocks thrusting on the

Oligocene sequence in two separate places (Tokça and Kuzunkaya locations) with the renewing movements of the Lycian nappes and indicated the presence of extensional basins in the Menderes massif at the same time. Although the relationship between the basement rocks and the Oligocene sedimentary sequence around Tokça was mapped as a steep angle normal fault (Göktaş et al., 1989), Akkiraz et al. (2010) presenting detailed maps showing that this relationship is a thrust and indicate that this sedimentary sequence is Rupelian-Early Chattian (Oligocene) in age.

In previous studies, it is observed that the Datça-Kale-Acı Göl basin was divided into sub-basins and different stratigraphies were proposed. The studies supplying age data for sedimentary successions rely on the facts of palynology (Akgün and Sözbilir, 2001; Akkiraz and Akgün, 2005) nannoplankton, foraminifera, mollusk (İslamoğlu et al., 2006; Gedik, 2008; İslamoğlu, 2008), palynology and benthic foraminifera (Akkiraz, 2008; Akkiraz et al., 2010, 2011).

Göktaş et al. (1989), revealing the stratigraphy of the Çardak-Tokça basin, reported that they were formed by deltaic shallow marine sediments where terrigenous inputs in places are available. Hakyemez (1989) indicates that the Karadere formation, which developed as the lowermost alluvial fan in the Kale basin, is conformably overlain by the coal-bearing Mortuma formation developed in lagoon environment consisting of braided and meandering stream deposits. He stated that these deposits are then unconformably overlain by the lower Miocene Yenidere formation.

Toker (2008) studied the Oligocene sequence in the Çardak-Dazkırı basin from bottom to top as Armutalanı, Çardak, Hayrettin, Tokça formations. Armutalan and Çardak formations were considered as the alluvial fan deposits (Toker and Yağmurlu, 2010).

Karadenizli et al. (2009, 2017) presents the generalized stratigraphy for Oligocene Datça-Kale-Acı Göl basin by the distinction of Mortuma, Çardak and Hayrettin formations. The Üçtepe reef member was also included in the Hayrettin formation. In facies analysis of the formations, the alluvial fan and fluvial, fan delta, sandy beach, shallow sea clastics, inner shelf carbonates and offshore deposits were determined (Figure 2).

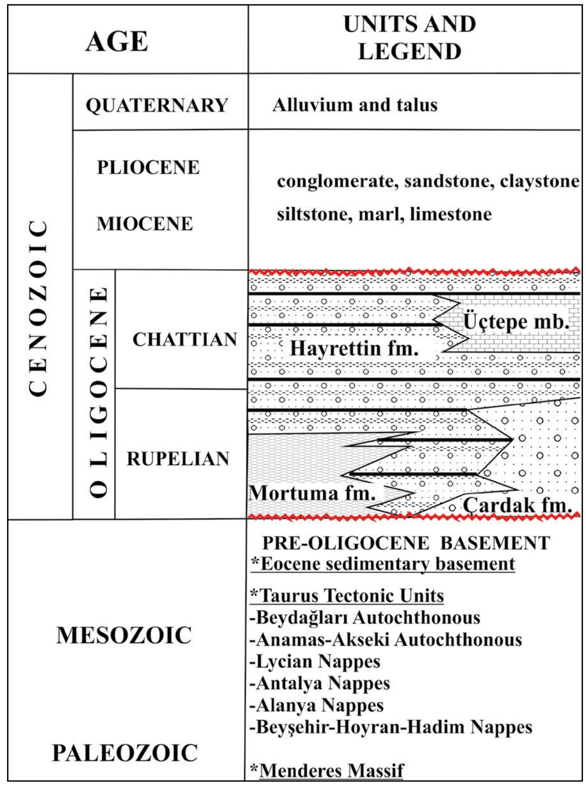

Figure 2- Generalized stratigraphical section of the Datça-Kale-Acı Göl basin [from Karadenizli et al. (2009)].

In this article, tectono-sedimentary development of the NE section of Datça-Kale-Acı Göl basin, where its basin-margin relationships were relatively less studied, will be explained by using the field observations carried out at key locations (Figure 3). Unlike previous studies, the margins, size and geometry of the basin will also be emphasized because the Oligocene period of time has a critical importance in the geology of Turkey.

2. Field Observations on the Southeast Margin of the Datça-Kale-Acı Göl Basin

2.1. Southwest of Çardak: İnceler-Söğütköy area (Figures 3 and 4a)

Datça-Kale main breakaway fault, turns into north-northeast direction and starts to be clearly observed in the western İnceler-Söğütköy area (Figures 1 and 3) after limiting the Kale-Tavas basin from the south (Yılmaz et al., 2000; Gürer and Yılmaz, 2002). The northwest dipping İnceler normal fault form the contact between the basement units consisting of the Lycian nappes and the Eocene sedimentary units

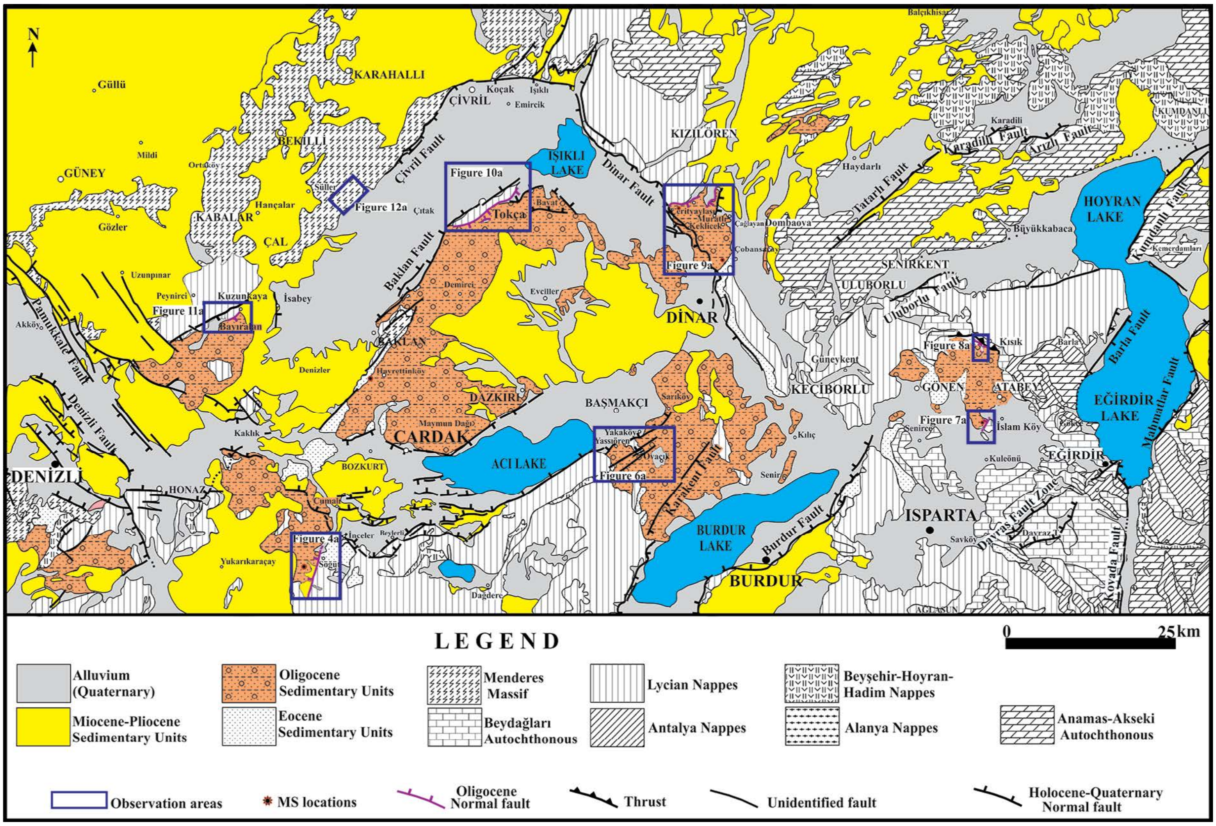

Figure 3- The simplified geological map of the northeastern part of the Datça-Kale-Acı Göl basin and the location of the detailed observation areas. See figure 1 for location. (from Konak, 2002; Turhan, 2002; Konak, and Şenel, 2002; Şenel 2002; Emre et al., 2013).

and the Oligocene-Neogene sequence (Figure 4a). While the lower levels of the sequence belonging to the Çardak formation, dominantly consisting of Oligocene coarse conglomerate and sandstone alternation, have high to medium dipping values (55-37^{o}), it becomes low dipping (10^{o}) as the dip value decreases transitionally towards upper layers (Figure 4b). The succession is disconformably covered by a probable Neogene sequence formed by red mudstones, armored mud-balls, limestone with plant parts and loose conglomerate. It is possible to see the Oligocene succession dominantly composed of conglomerates in the wedge geometry thickening towards the İnceler fault in deeply incised valley slopes (Figure 5a, b). This situation clearly shows that the İnceler fault was developed as a growth fault in the Oligocene and controls the deposition of the Oligocene sedimentary sequence. The İnceler fault should have continued its activity during and after the Neogene period.

The data, which is the first field observation and reveal the relationship between the tectonism and sedimentation in the Oligocene along the breakaway fault, similar to this observation is also observed in the submarine seismic reflection sections in the Gulf of Gökova (Kurt et al., 1999; Seyitoğlu et al., 2004; Seyitoğlu and Işık, 2015).

2.2. East and Southeast of Başmakçı: Yassıören-Atabey Area (Figure 3 and 6a)

In the south of Başmakçı, the footwall block of the active Acı Göl normal fault consists of the Lycian nappes, while the hanging wall block consists of the Quaternary deposits and the recent deposits of Acı Göl, which cover a large area in the region (Figure 3). The indirect data showing that the Acı Göl normal fault, working as active fault today, acts as a part of Datça-Kale main breakaway fault during the Oligocene period are given below.

The Maymun Dağ fault, located in the northwest of the Acı Göl, is the antithetic fault of the Acı Göl fault. In the footwall of Maymundağ fault, the apparent thickness of the Oligocene succession, which has low dipping angle, is at least 789 m and can be measured

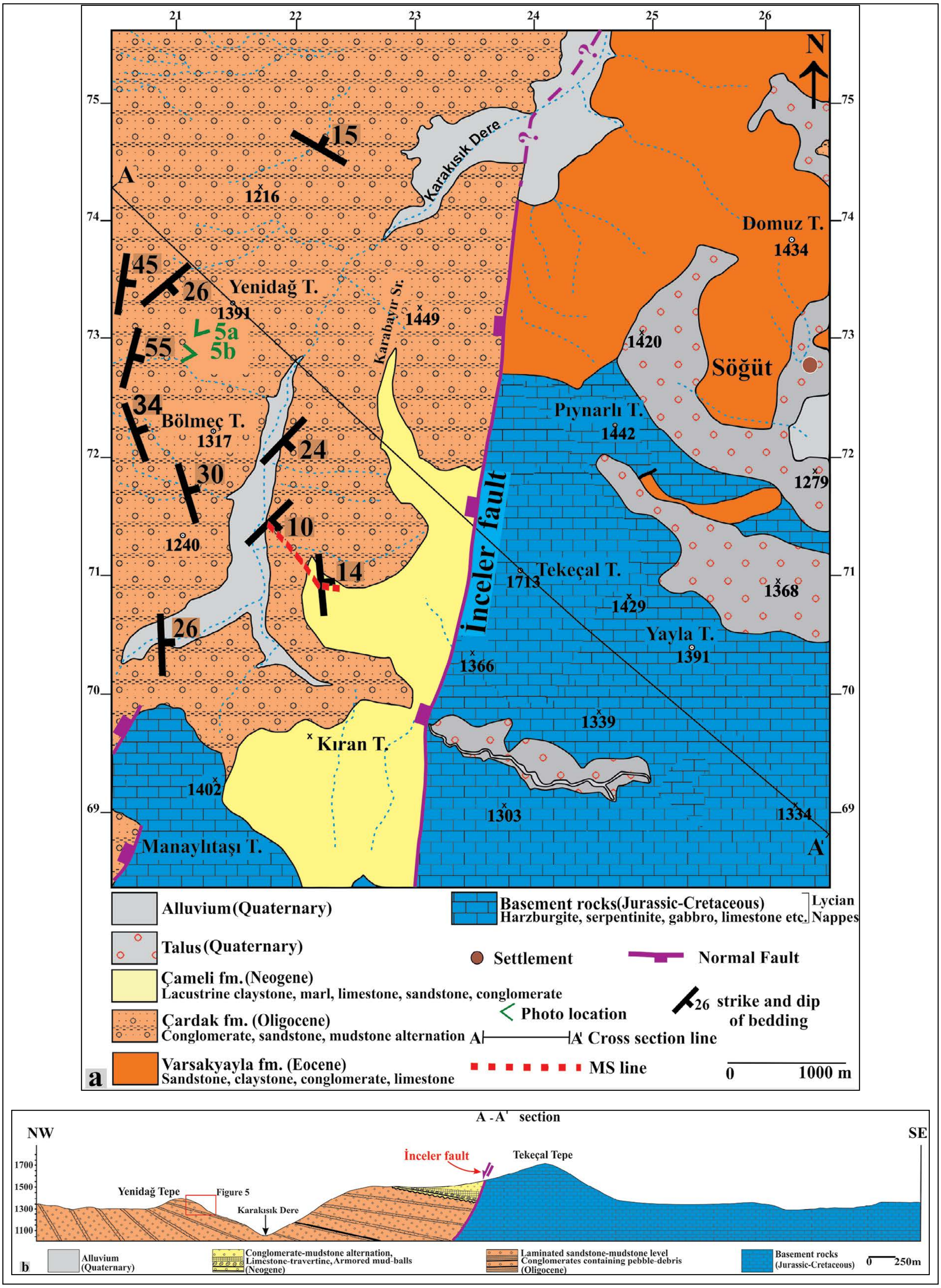

Figure 4- a) Geological map of İnceler-Söğütköy (from Şenel, 2010). See figure 3 for location and see figures 4b and 5a for photo location, b) Geological cross section showing the relationship between the İnceler fault and the basement rock and the Oligocene-Neogene units (red rectangle shows the location of the photograph in figure 5a).

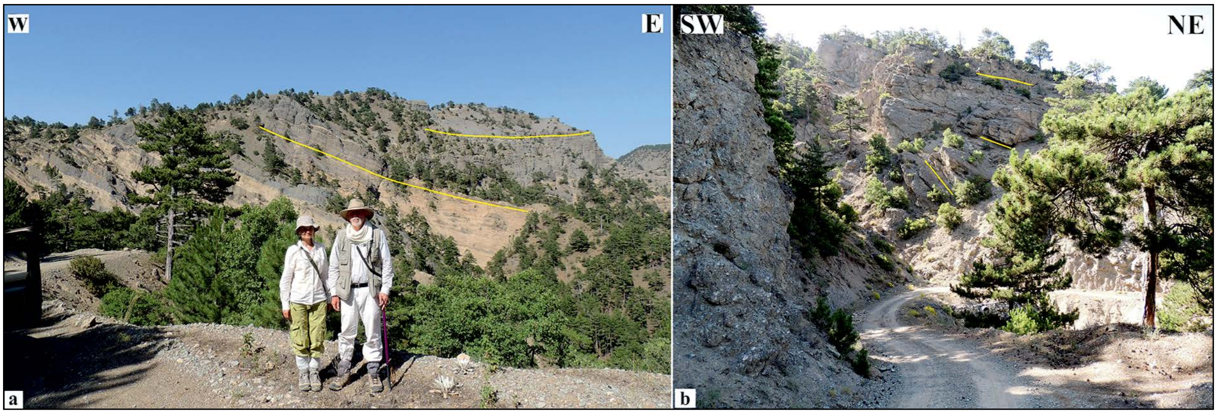

Figure 5- a) The thickening wedge geometry of the Oligocene succession in İnceler-Söğütköy area, towards the İnceler fault outside the photo frame, b) Close-up view of the wedge geometry. Yellow lines indicate bedding planes.

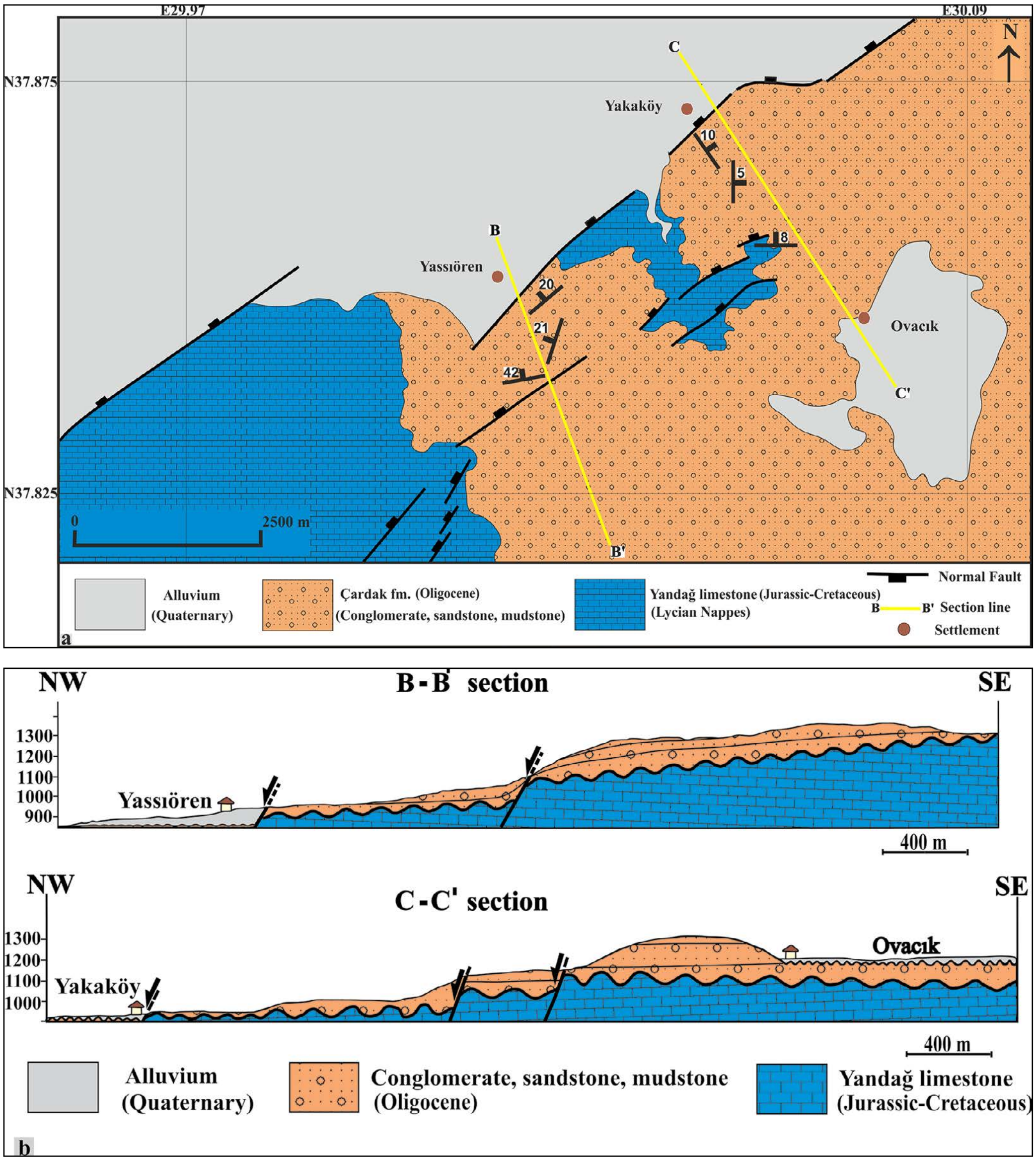

Figure 6- a) Geological map of Yassıören, see figure 3 for location, b) Geological cross sections of Yassıören and Yakaköy (See figure 6 for location).

between the summit of the Maymun Dağ and the Acı Göl level. It is concluded that there should be an Oligocene succession as much as observed on the Maymun Dağ below the Quaternary plain in the Acı Göl and its close vicinity. Accordingly, it can be suggested that the Acı Göl fault behaved as a segment of the Datça-Kale main breakaway fault in the Oligocene and controlled the deposition of the Oligocene successsion by benefiting from the thickness difference of the Oligocene succession at the footwall and hanging wall blocks of this fault. This recommendation is supported by field observations in the vicinity of Yassıören Village (Figures 3 and 6). The segments of the Acı Göl fault separates the rocks of the Lycian nappes and the unconformably overlying Oligocene clastic sequence from the Acı Göl Quaternary sequence (Figures 6a, 6b). The observation of Oligocene succession both at the footwall and hanging wall blocks of this active fault and that the Oligocene succession observed at the footwall block is thinner (250-500) than the succession observed at the Maymun Dağ (798 m) shows that the Oligocene succession at the footwall block of the Acı Göl fault is the overlapping/overlying section on the uplifting block of the normal fault (Acı Göl Oligocene segment) limiting the basin in the Oligocene period (Figure 6a, 6b). It is observed that the succession overlying the Acı Göl Oligocene segment of Datça-Kale main breakaway fault extends to Atabey, north of Isparta (Figure 3).

The bottom of the Oligocene succession (Akkiraz et al., 2011), which generally consists of conglomerates at the Kırkdağ Tepe area (Figure 7) in the south-southwest of Atabey, is observed in the hanging wall of a northeast-southwest trending normal fault dipping northwest (Figure 7a, 7b, 7c). The relationship of the upper levels of this sequence with the pre-Oligocene basement is observed in the north of Atabey (Figure 8a, 8b). The basement rocks composed of recrystallized limestones in this area thrust over Eocene sandstone-mudstone alternation (Figure 8c). The east-west trending south dipping normal fault developed immediately in front of the thrust limit the Oligocene conglomeratic succession that overlies folded Eocene units with an angular unconformity. In the hanging wall of this fault, another normal fault is overlapped by the Oligocene sediments (Figure 8a, 8b, 8c, 8d, 8e). This feature is a sign of a syn-tectonic sedimentation in the Oligocene.

The main breakaway fault, which limits the Datça-Kale-Acı Göl basin from the southeast, cannot be clearly traced towards the northeast due to the younger northwest-southeast extending Dinar fault. The Oligocene succession located at the footwall block of the Dinar fault unconformably overlies the horst in the north of Senirkent as a relatively thin sequence. As this situation resembles the situation at the footwall block of the Acı Göl fault it is possible that the main breakaway fault is located around Tatarlı in further northwest, and even if it extends further northeast under the Quaternary deposits, it will have to be cut in the northeast by the northwest-southeast trending Afyon-Akşehir graben (Figure 3).

3. Field Observations on the Northwestern Margin of Datça- Kale-Acı Göl Basin

3.1. Cerityaylası Area (Figures 3 and 9)

The succession of the Oligocene Çardak formation on the footwall block of the Dinar normal fault, which also produced the Dinar earthquake on the 1st of October in 1995, overlies the Eocene sediments to the west of Çobansaray with an angular unconformity (Figure 3). As heading towards further northwest, it was observed that this succession was limited by northeast-southwest trending southeast dipping enechelon Cerityaylası and Muratlı normal faults (Figure 9a, 9b). The dip of the Oligocene succession decreases in up section and overlies the Muratlı fault (Figure 9e). This shows that the deposition of Oligocene succession is controlled by the Cerityayla and Muratlı faults (Figure 9b, 9c).

3.2. Tokça Area (Figures 3 and 10)

There are different opinions about the characteristic of the tectonic contact forming the northwestern boundary of the Datça-Kale-Acı Göl Oligocene basin between the Triassic - Cretaceous recrystallized limestones and the Oligocene sedimentary sequence in the footwall block of the Baklan graben, which is confined by the Baklan fault (Figure 3) around Tokça. This contact was mapped as thrust by Sözbilir (2005) and Akkiraz et al. (2010) and the sedimentary sequence at the footwall block was found to be of Rupelian-Early Chattian (Oligocene) age. On the other hand, the same contact was mapped as the steep angle normal fault by Göktaş et al. (1989). According

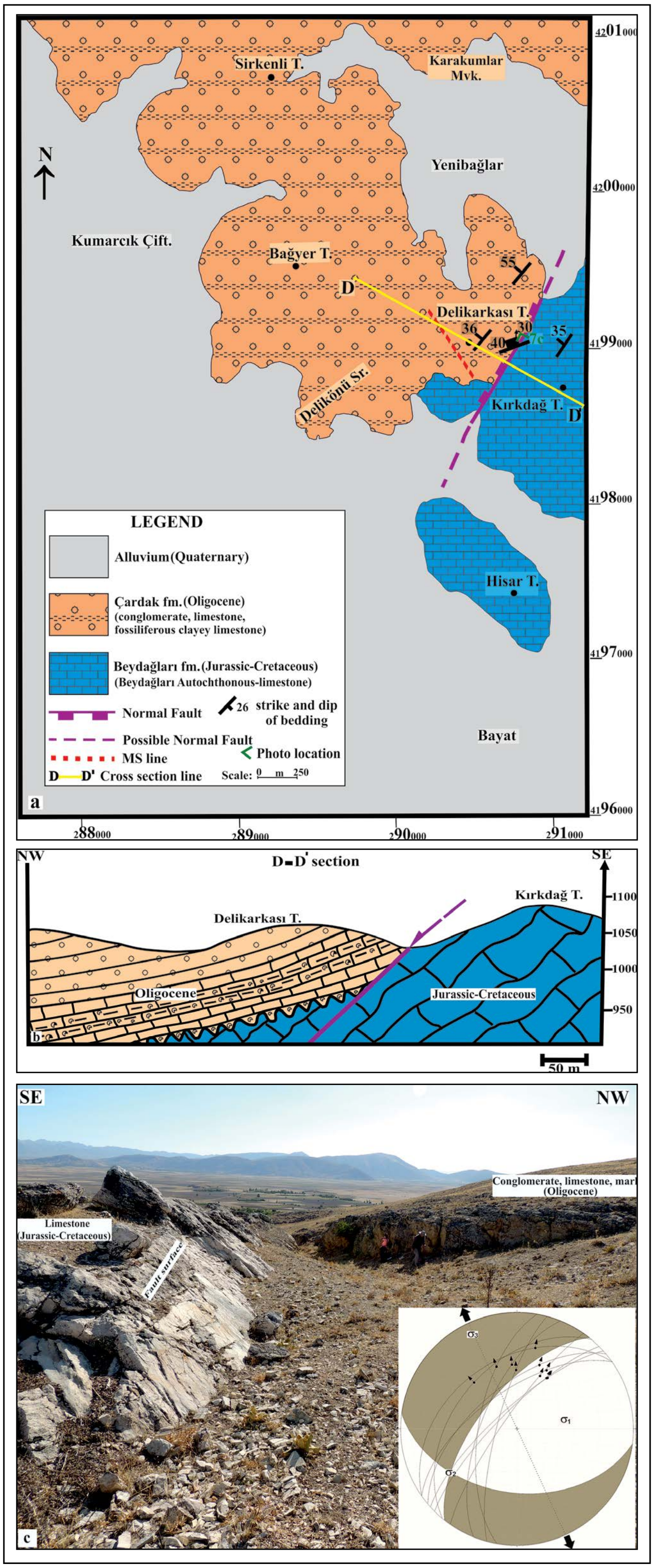

Figure 7- a) Geological map of Atabey-Kırkdağ. (from Şenel, 2010). See figure 3 for location, b) Geological cross-section of the Kırkdağ Tepe area. See figure 7a for location, c) The field view of the normal fault between Jurassic-Cretaceous units and Oligocene Çardak formation and the fault plane solution indicating the normal fault based on measurements taken from the fault plane (looking from NNE).

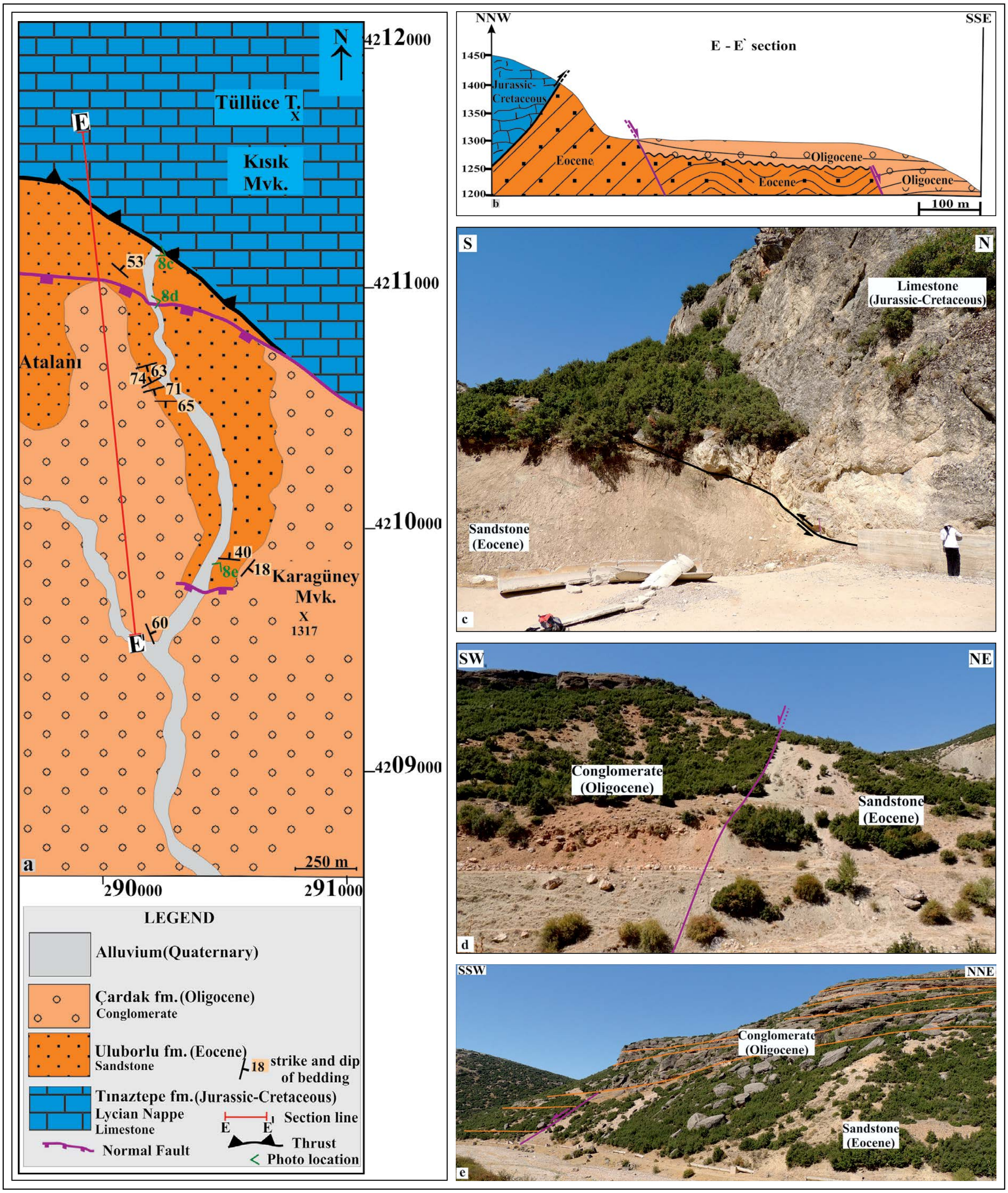

Figure 8- a) Geological map of the north of Atabey, see figure 3 for location, b) Geological cross section, the north of Atabey, c) Thrust between Jurassic-Cretaceous Recrystallized limestone and Eocene sandstones, looking west (Thrust plane is measured as E-W 40N), d) Normal fault contact between the Eocene sandstones and the conglomerates of the Oligocene Çardak formation, e) Normal fault overlapped by the conglomerates of the Oligocene Çardak formation.

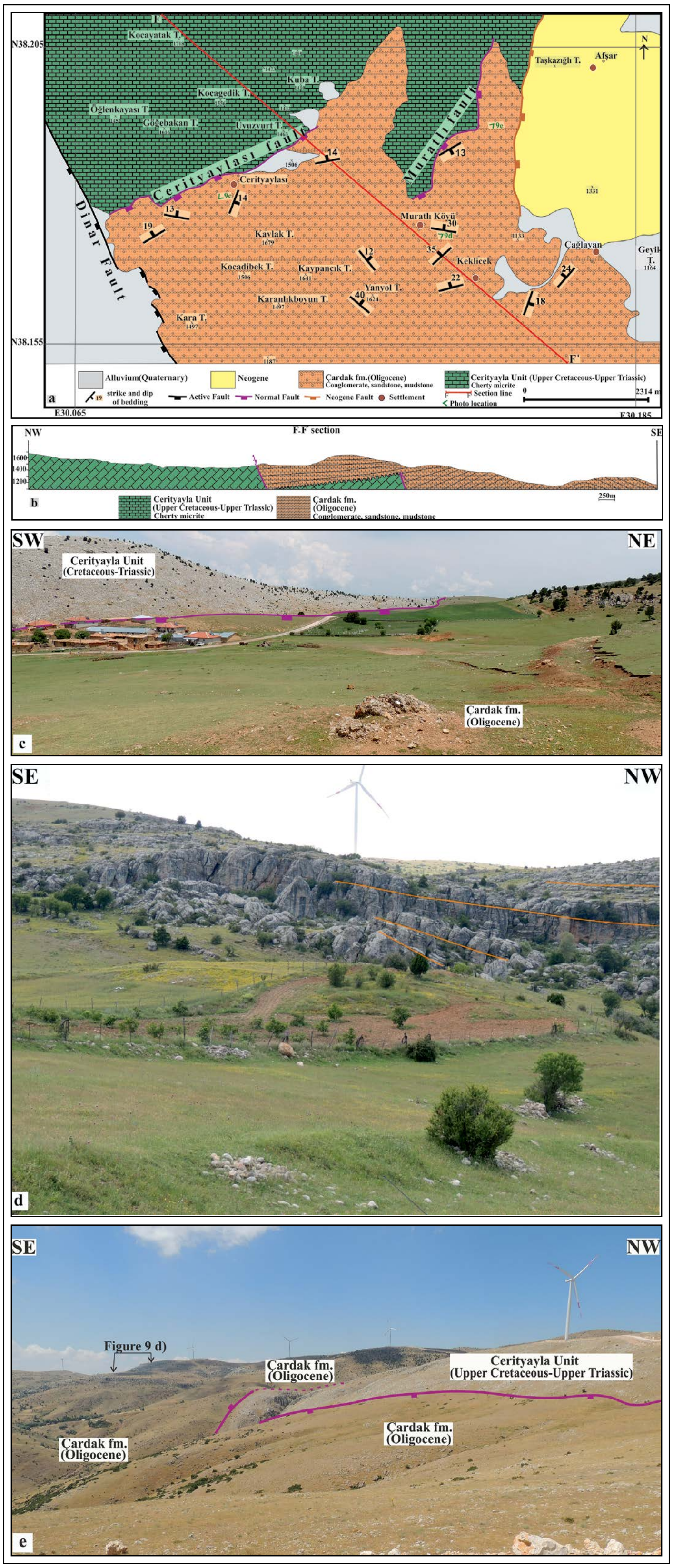

Figure 9- a) Geological map showing the Cerityaylası-Muratlı faults, see figure 3 for the location, b) Geological cross section of Cerityaylası, c) the view of Cerityaylası fault on the field, d) The wedge geometry thickening towards the Muratlı fault in the Oligocene Çardak formation, e) the overlapping of the Muratlı normal fault by the Çardak formation.

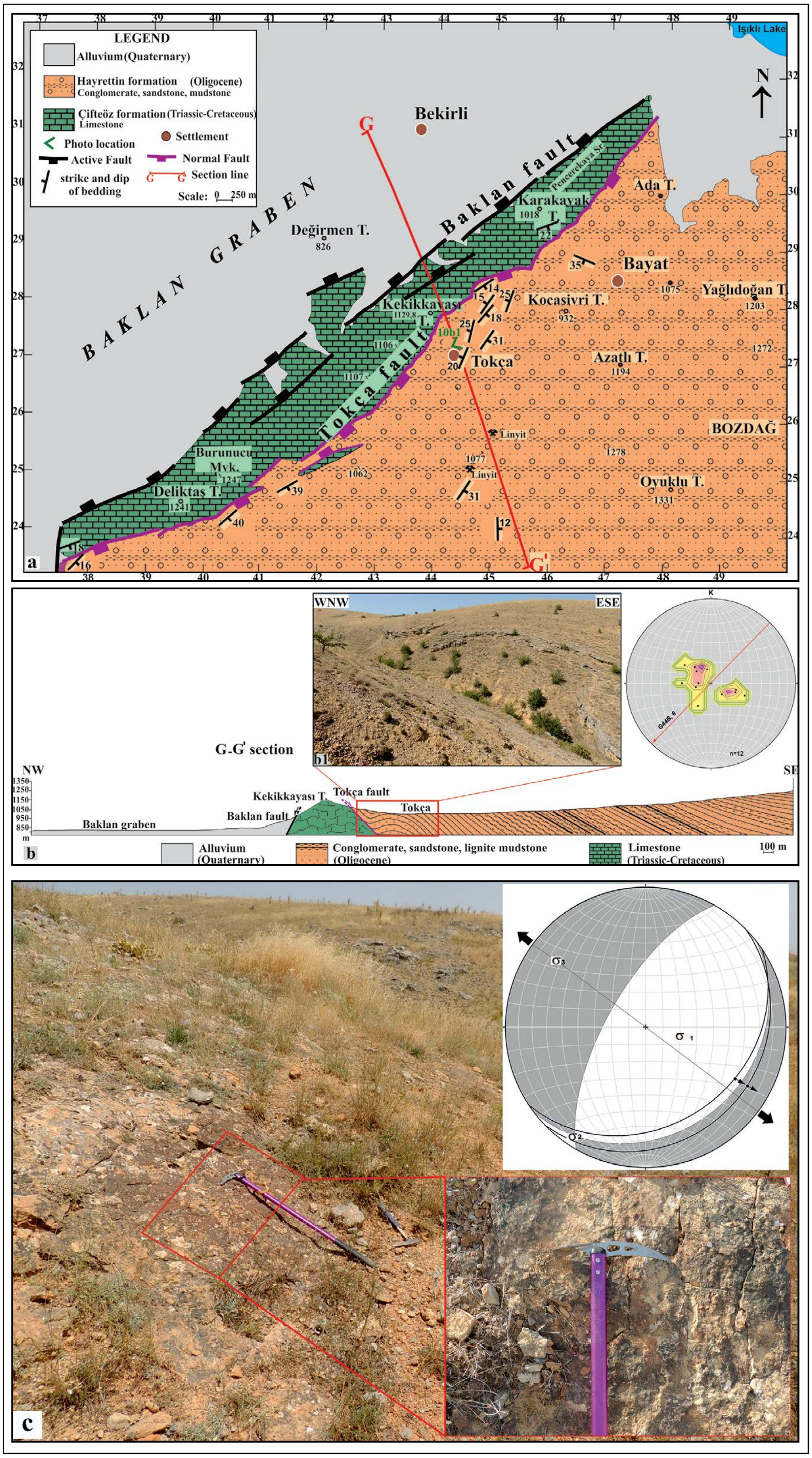

Figure 10- a) Geological map of Tokça, for the location see figure 3, b) the geological cross section and the structural data belonging to fold axes developed parallel to the fault between the Oligocene Hayrettin formation and Triassic-Cretaceous Çifteöz formation, the average trend of fold axes: N44E, plunge: 6°, c) The oxidized fault plane on limestones and the solution of the fault plane indicating normal fault (the fault plane: N56E, 31SE, and slip striations: N63W, 26SE).

to our field observations, the tectonic contact between the Triassic-Cretaceous recrystallized limestone and the Oligocene sedimentary units is a northeast-southwest trending normal fault dipping southeast. Tokça fault can be followed along 13 km and consists of 4 segments (Figure 10a, 10b). There are traces of hydrothermal activity in breccias in the fault zone. It has been possible to measure the fault plane and slip striations at one location in the fault zone. It is very clear that the dip direction of the Tokça fault surface and the movement on it indicate a normal fault character (Figure 10c). The Oligocene sedimentary units in the Tokça normal fault contact are composed of carbonate cemented, sub-rounded, grain supported, coarse pebbly conglomerates and show open folds. The fact that the fold axes are parallel to the Tokça normal fault (Figure 10b) also indicates that these folds are related to normal faulting. As moving away from Tokça normal fault towards southeast, the Oligocene sedimentary sequence is found to be uniformly dipping to the southeast (Figure 10b).

3.3. Kuzunkaya Area (Figures 3 and 11)

It was reported that the ophiolitic basement had thrusted over the Oligocene sedimentary units at Kuzunkaya, the north of Bayıralan in the west of İsabey (see Sözbilir, 2005, figure 15). However, the field observations carried out in the region indicate that the boundary between the ophiolitic basement and the Oligocene sedimentary units is an east northeast-west southwest trending normal fault dipping steeply southeast. (Figures 3, 11a, b, c). The drag fold syncline in the hanging wall block of the fault was used to determine the direction of movement (Figures 11b, c).

Generally the field observations on the northwest side of the Datça-Kale-Acı Göl basin indicate that the margin of the basin is limited to an antithetic normal fault system of Datça-Kale main breakaway fault. Cerityaylası and Muratlı faults served as growth faults (Figure 9d).

4. Microtectonic Findings within the Northwest Extension of the Datça-Kale Main Breakaway Fault

The lithology of the metamorphic rocks in study areas is marble, calc-schist and calc-silicate schist. Our mesoscopic and microscopic studies in these rocks reveal that the rocks were affected by the mylonitization with varying grades. Carbonate minerals (calcite) constitute the common mineral composition of these rocks. Phyllosilicate minerals (biotite, chlorite, muscovite, sericite), quartz, feldspar and amphibole accompany rock composition in different proportions. Epidote and opaque mineral are also found as an accessory mineral in the rock.

The primary foliation of the rock protolith is defined by the elongation of the phyllosilicate minerals. These foliation planes are largely overprinted and cut and/or deflected by mylonitic foliation. Mylonitic foliation is characterized by recrystallized calcite minerals aligned in foliation surfaces. Also the recrystallized phyllosillicate minerals accompany the formation of mylonitic foliation which showing folding in geometries. Stretched mineral clusters along the mylonitic foliation represent the mylonitic lineation. The isolated mineral groups with extensional geometry on mylonitic foliation planes represent the mylonitic lineation.

The mylonitization in rocks is depend on the primary composition and textural properties of the rock. The mylonitic rocks which are wholly or mainly of carbonate composition contain the recrystallized calcite minerals. Some of the mylonitic rocks are formed by fine and medium grained recrystallized calcites. In some of the mylonitic rocks, these fine and medium grained recrystallized calcites and very fine-grained recrystallized calcites occur as matrix material which surround large calcites known as porphyroclast. These rocks also include intensively altered amphibole porphyroclasts, some opaque minerals and altered coarse phyllosilicate porphyroclasts. Development of fractures particularly in calcite porphyroclasts and the presence of recrystallized calcite and quartz grains in opening areas suggest that the deformation of these minerals occurred during extensional regime.

Undulatory extinction and twinning development is remarkable in calcite porphyroclasts, which indicates that the temperature is between 200 and 300 ºC during deformation. The quartz grains, in some thin sections also display partly recrystallization and typically undulatory extinction. These properties of minerals suggest that the temperature is at 250°C or above during the deformation. When we consider the regional geothermal gradient as 30°C/km, it is possible to say that the deformed minerals in the mylonitic rocks may be deformed at depths of 6-10 km.

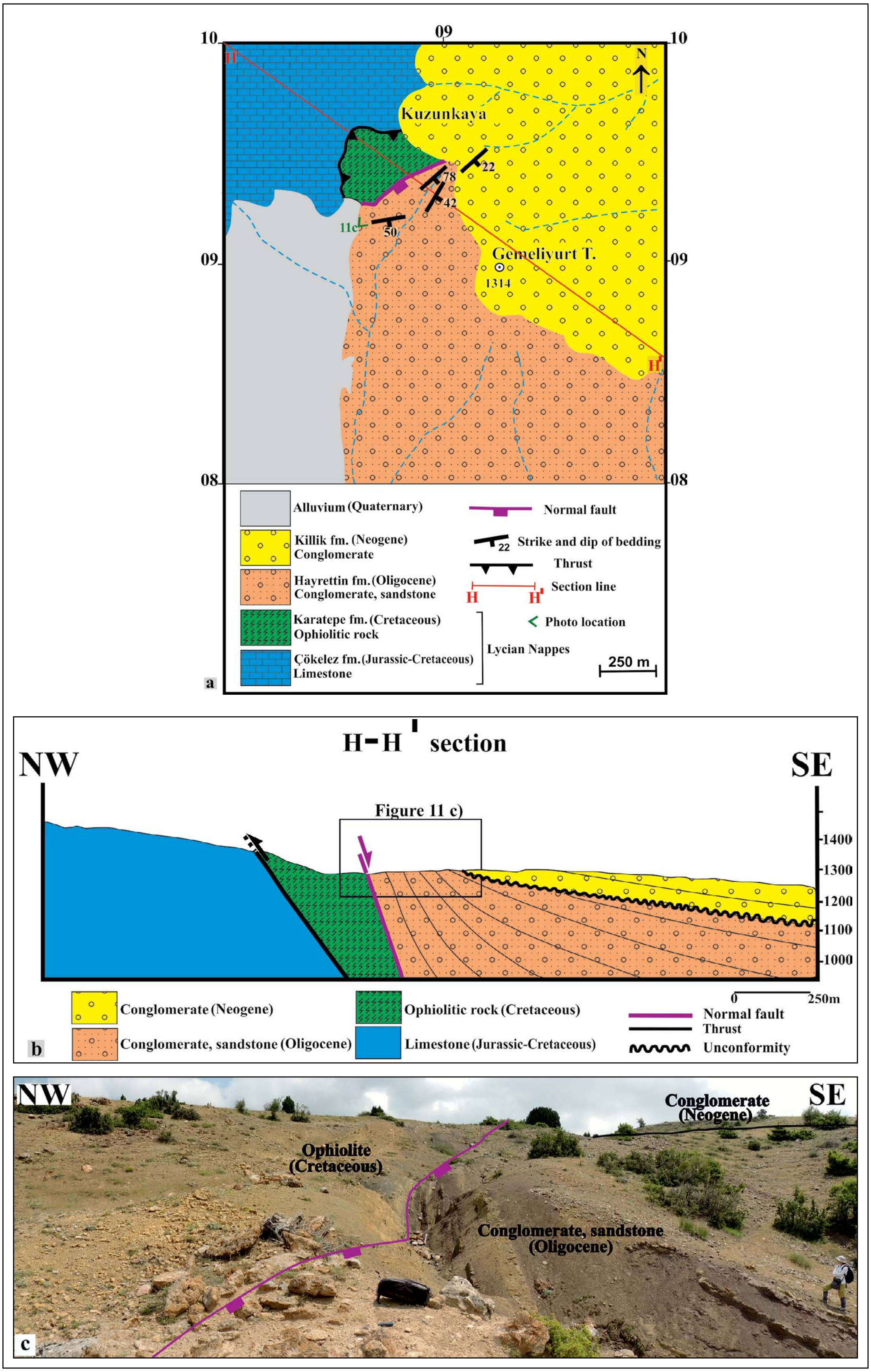

Figure 11- a) Geological map of the vicinity of Kuzunkaya, see figure 3 for location, b) the geological cross section of the Kuzunkaya. (The reverse fault relationship from Konak et al., 1986, the black rectangle is the photo location in figure 11c), c) Photo showing the normal fault boundary between the Oligocene Hayrettin formation and the ophiolitic basement (Karakaya formation) (see figure 11b for location).

The thin sections with parallel to the stretching (mylonitic) lineation include some data on the kinematics of ductile deformation in the rock. The S-C structure and the asymmetric porphyroclast formations are dominant kinematic indicators in the study area (Figure 12a, b). It is also seen typical oblique foliation. Kinematic indicators suggest that mylonitization has top-to-the-N-NE sense of shearing. In other words, during the development of the ductile shear zone, the lithologies above the zone might be moved toward the North. At the same time, the kinematic indicators designate that ductile deformation in the region is related to simple shear. All these findings are consistent with the well known kinematic indicators and sense of shearing in the regional extensional regime obtained from the Menderes core complex (Işık et al., 2001, 2003, 2004; Işık, 2004).

5. Tectono-Sedimentary Evolution of the Northeastern Datça-Kale-Acı Göl Oligocene Basin

For the northeastern part of the Datça-Kale-Acı Göl basin, the Cerityayla, Çobansaray, Hayrettin, Söğütköy and Atabey measured stratigraphic sections were prepared (Figures 3, 13a, b). The relative location of these measured stratigraphic sections in the basin and the location evaluation related to the area where microtectonic observations are made is presented in figure 14.

It is possible to mention about three separate Oligocene successions of the northeastern part of the Datça-Kale-Acı Göl basin. The first of these is the İnceler-Söğütköy sequence to the south of the Acı Göl, where thick coarse clastics are present. This sequence, which is observed as two separate outcrops and highly probable that they are the continuation of each other, is composed of normal graded beddings with a thickness of 15 - 50 cm mainly dominated by coarse sand-medium pebbles.

Two most striking features of the succession are the minority of silt-clay size grains and the decreasing of the primary bedding dip from bottom to top. Clay leaching is a good reagent for high energy aqueous environments. The decrease of the layer dipping can be data for rapid accumulation and active tectonism during deposition. In the upper continuation of this outcrop, the sedimentary structure and textural characteristics observed in the beach sediments (the abundance of well-rounded but weakly spherical platy, long axis orientation in grains, and unavailability of clay and silt grains) were seen. Taken together, it is understood that this coarse grained sequence was deposited as a coarse-grained delta and/or fan delta in a shallow marine environment.

The coal bearing Oligocene successions in the vicinity of Maymun Dağ and Tokça have thinner grain size. The characteristics of sequence observed as fine grained conglomerate-sandstone in the vicinity of Maymun Dağ is that it has impoverished by clay, which is well washed. This situation is an expression of relatively high energy and indicates that the sediments were accumulated in a shallow sea or coastal environment. The coal bearing sequence

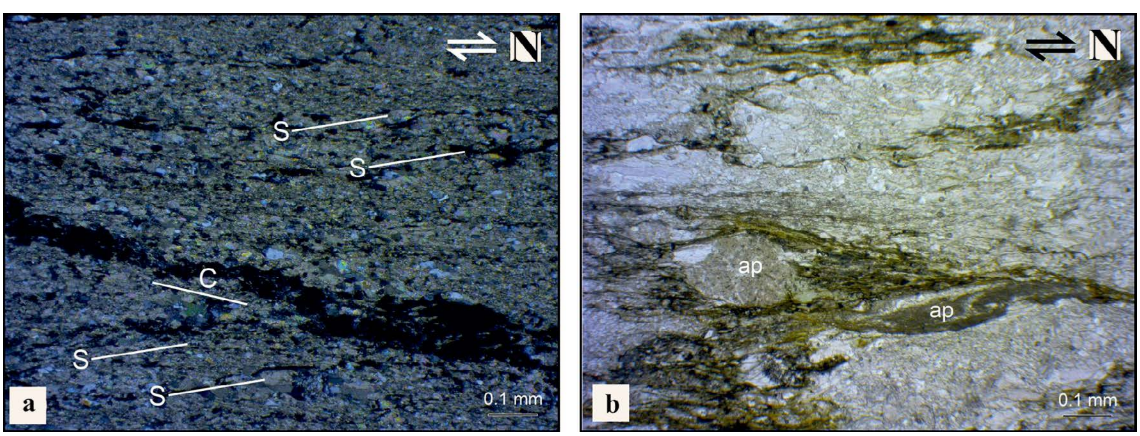

Figure 12- Microscopic view of some microstructures commonly observed in metamorphics forming the basement rocks in the study area, see figure 3 for location. The kinematic indicators in the oriented sample show that the movement in the regional deformation is upper-north, a) S-C structure. (Cross nicol), b) Asymmetric porphyroclast (single nikol). ap: asymmetric porphyroclast; N: North.

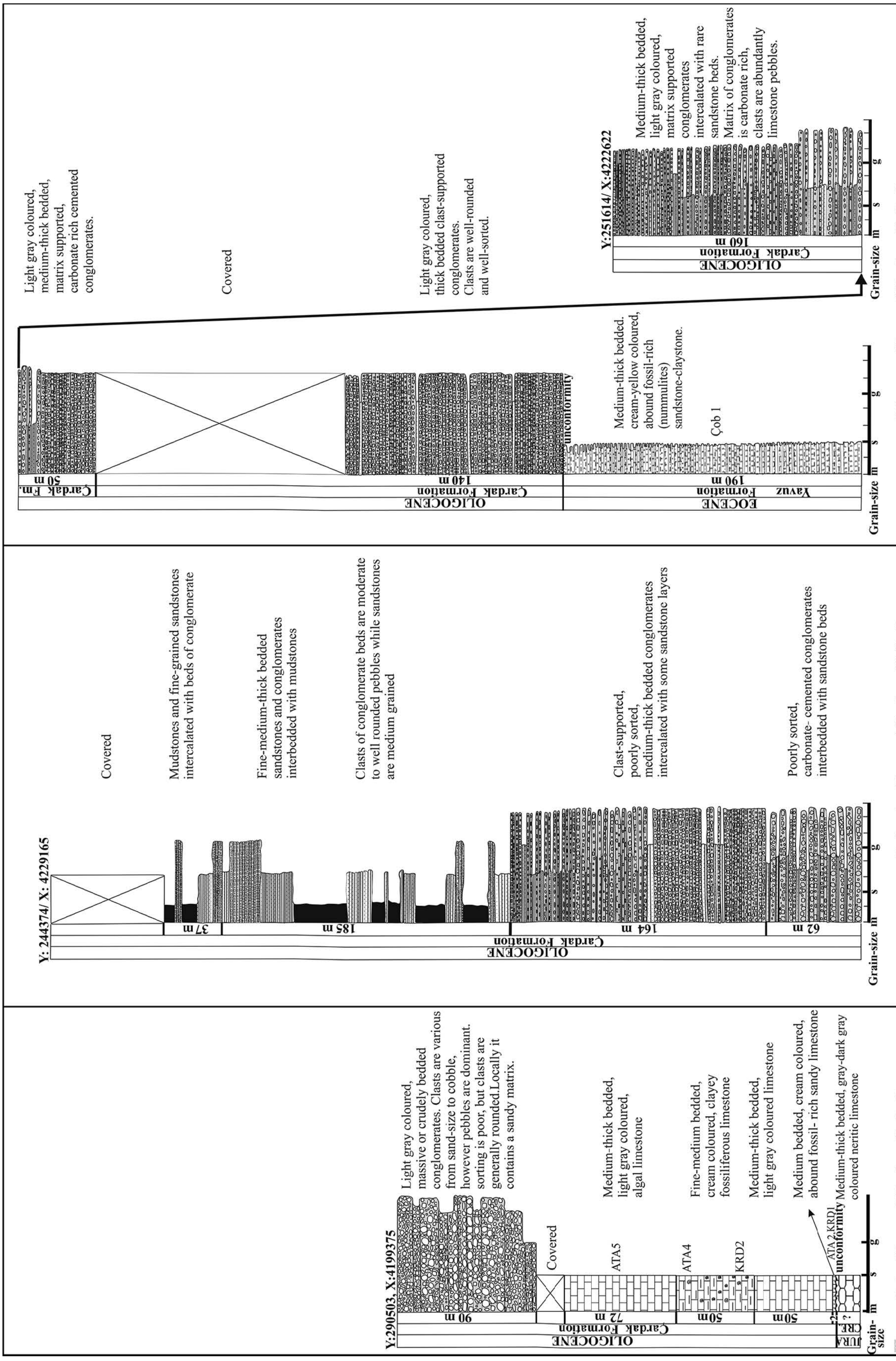

Figure 13- a) The measured stratigraphic sections taken from the NE section of the Datça-Kale-Acı Göl basin. See figure 3 for location.

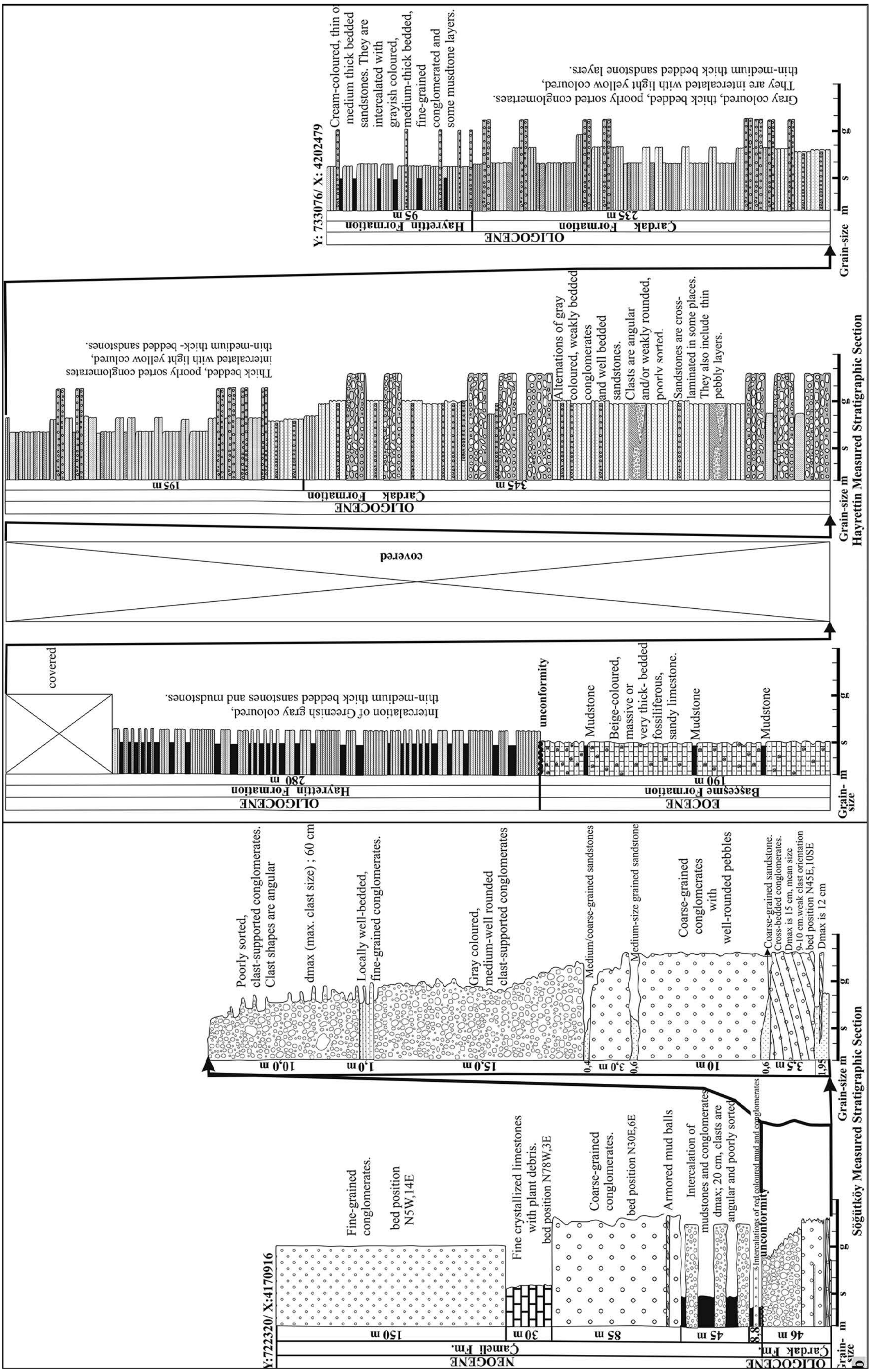

Figure 13- continue, b) The measured stratigraphic sections taken from the NE section of the Datça-Kale-Acı Göl basin. See Figure 3 for location.

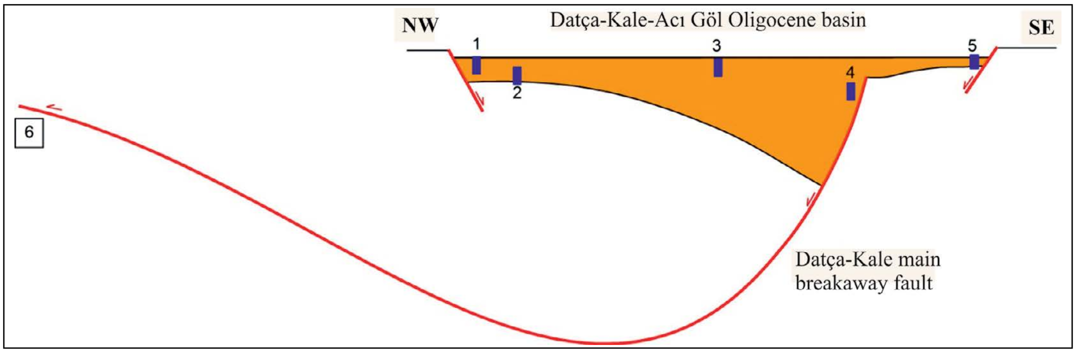

Figure 14- Representative cross-section showing the relative positions of measured stratigraphic sections in the northeastern part of the Datça-Kale-Acı Göl basin. 1-Cerityaylası, 2- Çobansaray, 3-Hayrettin, 4- Söğütköy, 5-Atabey measured stratigraphic sections, 6-Location of microtectonic observations in the vicinity of Süller in the lower plate of Datça-Kale Main breakaway fault.

around Tokça is different from the previous ones with marl - claystone - siltstone lithology. Lamination and soft sedimentary deformation structures are evident. It is composed of clay dominated sediments. It is low in energy and probably indicate marine-marsh environments. It is possible to interpret the coals as paralic environment products.

In the horst of the Dinar graben, Oligocene units in the vicinity of the Cerityaylası show similarities with the Söğütköy sequence in terms of grain size. These units to be in red color in places are secondary and it is not a depositional characteristics. In addition to this, the clay grains were washed less. It is possible to interpret them as alluvial fan - fan delta sediments.

In general, these deposits represent shallow marine coastal environments. It would be appropriate to talk about a tectonically controlled deposition. The excess thickness in narrow range is an indication of tectonism.

Considering all field observations and measured stratigraphical sections, it is clear that there is an effective tectonic control on the SW margin of the Oligocene Datça-Kale-Acı Göl basin. This situation was achieved by the İnceler and Acı Göl faults which are the continuation of Datça-Kale main breakaway fault in NE. Cerityayla and Tokça faults, which are developed as antithetic to these normal faults, are lower profile structures that limit the basin from NE (Figure 15).

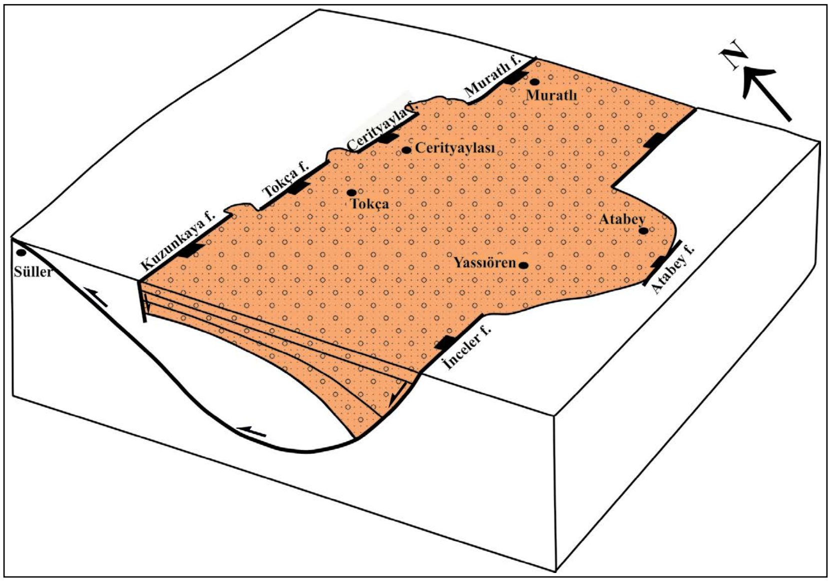

Figure 15- Schematic block diagram showing the status of the northeastern part of the Datça-Kale-Acı Göl basin in the Oligocene.

6. Discussion and Results

Considering the covered and eroded outcrops in addition to their areal distribution, the Oligocene Datça-Kale-Acı Göl basin is interpreted to be a marine deposition area with a geometry of 50-75 km wide, about 300 km long. Special depositional systems provided by the geometry of narrow and long sedimentary areas are in concern. The modern examples of these are fjords and there is observed sediment only on basin axes as basin margins are in the form of slope (Hansen et al., 2007). However, Miocene Köprü and Manavgat basins can be given as examples for the old basins (Çiner et al., 2008). While the sedimentary centers of these are relatively long, the basin margins accumulate more and various sediments (Kostaschuk and McCann, 1983; Hansen, 2004). The additional feature of Datça-Kale-Acı Göl Oligocene basin is that the two sides of the basin are faulted but the activity of the fault on one side is dominant and accumulates more sediment due to tectonism. In summary, the presence of different successions in different localities is the usual result of the basin geometry and forms a good example for old fjord type basins.

The field observations carried out in northeast of the Oligocene Datça-Kale-Acı Göl basin show that the Datça-Kale main breakaway fault, which limits the basin from the southwest, is represented by İnceler and Acı Göl faults. The Oligocene sequence showing the wedge geometry in the hanging wall block of the İnceler fault reveals that this fault developed as syn-sedimentary. The fact that the Oligocene succession on the footwall block of the Acı Göl fault is very thin in comparison with the succession observed on the Maymun Dağ led to the evaluation that the Oligocene deposits in this section were formed by overlying the basin-margin faults. The relationships of the Oligocene deposits of Cerityaylası and Muratlı faults, which are located in the northwest margin of the basin as an antithetic of the Oligocene Datça-Kale main breakaway fault, show that they are syn-sedimentary faults (Figure 9d). It was determined that Tokça fault was not a thrust fault as claimed in previous studies but it had a normal fault character and represented the northwestern edge of Datça-Kale-Acı Göl basin together with Cerityaylası and Muratlı faults. The Menderes massif was exhumed with the bending of Datça-Kale main breakaway fault and it was revealed that up to the north-northeast movement took place also in the vicinity of the Süller by means of microtectonic studies performed on the lower plate.

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