Kinematic Characteristics of the Central Part of Karaisalı-Karsantı Fault Zone, Southern Turkey

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Abstract— Turkey is located in the Alpine-Himalayan Orogenic Belt and represents one of the seismotectonically most active regions of the world. Collisional, extensional and strike-slip tectonic regimes lead its seismicity. There are many faults about which quite limited information is available in especially central and southern parts of Turkey that accommodate many faults defined in this context. With its ~150 km length the Karaisalı-Karsantı Fault Zone is one of the most important tectonic structures of southern Anatolia. Information about the fault zone, which is described as a 'potentially active fault' on the current active fault map, is considerably limited. However, the region dominated by the fault hosts two densely populated metropolitans of Turkey; Adana and Mersin cities. Current literature related to the fault define it as a left-lateral strike-slip fault basing on the morphological criteria. It was concluded from our structural analysis conducted on fault planes located at the central part of Karaisalı-Karsantı Fault Zone that it is a normal fault with a minor left-lateral. The obtained data indicate that the information about the characteristics of important faults in southern Anatolia is imperfect and the region's structure and seismology need to be examined in more detail to identify its active tectonics more reliably.

Index terms – Tectonics, transtension, southern Anatolia

I. INTRODUCTION

Turkey is one of the seismotectonically most active regions of the world [1]. Among the geological resources that control the activity are the collision between the Arabian and Eurasian plates in the east of the country and the extension in the west [2, 3]. The movement between these regions corresponds to the North Anatolian Fault Zone and the East Anatolian Fault Zone [4] (Fig. 1). NE-SW trending Central Anatolian Fault Zone, located in the inner section of Anatolian plate and stretching approximately 700 km is one of the most significant faults that dominate the tectonics of central and southern Anatolia [5]. The Karataş-Osmaniye Fault Zone that represents SW-trend of East Anatolian Fault Zone towards the southern part of central Anatolia is another structural element [6]. The Karaisalı-Karsantı Fault Zone, located between the Central Anatolian Fault Zone and the Karataş-Osmaniye Fault Zone, qualifies one of the significant fault zones in southern Turkey [7, 8] (Fig. 2).

The Central Anatolian Fault Zone and the Karataş Osmaniye Fault Zone as well as the Karaisalı-Karsantı Fault Zone located between the other two faults and subject to this study are defied as left lateral strike-slip faults [7] (Fig. 2).

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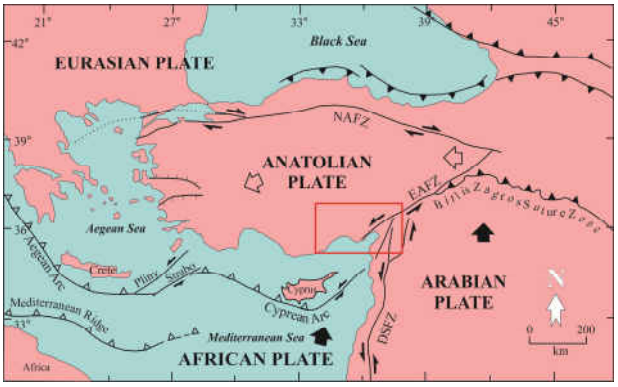

Fig. 1. Neotectonic framework of Turkey and surroundings (modified from [4] and [9]).

Fig. 2. Major neotectonic fault zones in south-central Turkey (after [8]).

However, published structural data are available only for the southwestern section of the Central Anatolian Fault Zone [5, 10] and no kinematic study conducted in relation with the Karaisalı-Karsantı Fault Zone. The most significant characteristic of these faults is that many of them are represented as 'active' or 'potentially active faults' on the Active Fault Maps of Turkey [8, 11]. Many faults that extend parallel to each other in the central part of Karaisalı-Karsantı Fault Zone are evident both in the previous studies and satellite images. This study covers the structural observations carried out along the central part of Karaisalı-Karsantı Fault Zone.

II. GEOLOGICAL SETTING

The study field covers an area of 400 km^2 among the villages of Çukurbağ, Kuşçular, Durak and Çiftlikköy in the southern part of Central Taurus (Fig. 3). The aim is to specify structural characteristics of the central part of Karaisalı-Karsantı Fault Zone. In the study area, there are five major groups of rock units. These include Jurassic-Cretaceous aged limestones, which constitute the basis of Pre-Oligocene period and are indicated as a single

unit in Figure 3, the Oligo-Miocene aged Gildirli Formation, the Early-Middle Miocene aged Kaplankaya and Karaisalı formations, and Quaternary aged alluviums that covers small areas along the Karaisalı-Karsantı Fault Zone [10, 12-17].

The Oligo-Miocene aged Gildirli Formation is generally represented by coarse-grained materials and carbonate rocks with thin coal levels in some levels. It is conformably covered by the Early-Middle Miocene aged Kaplankaya formation which is mainly composed of shale [18]. The Karaisalı formation covers the largest surface area in the study field and hosts the largest part of Karaisal-Karsantı Fault Zone. The Karaisalı formation is composed of reefal limestones. Disintegrated surface colour is observed as gray-light gray in general, and its freshly broken surfaces indicate the colours of yellow/smoky yellow. The bottom of the unit is composed of slightly silt, bioclastic, interbedded, medium-thick layered and partly nodular limestones, while the lower levels consist of reefal limestones that contain algae, coral pieces, foraminifera, gastropoda and echinoid fossils [12]. This unit has a massive look in general and is partly medium-thick layered. Due to tectonic and atmospheric factors, surface of the Karaisalı formation has a fractured structure with karstic voids. Earlier researchers suggested that the age of the unit, which has horizontal and vertical transitions with the lower and upper units, was Serravalien-Burdigalian [12,16]. Quaternary aged alluviums and talus deposits are formed along the fault that is the subject of our study [19] (Fig. 3).

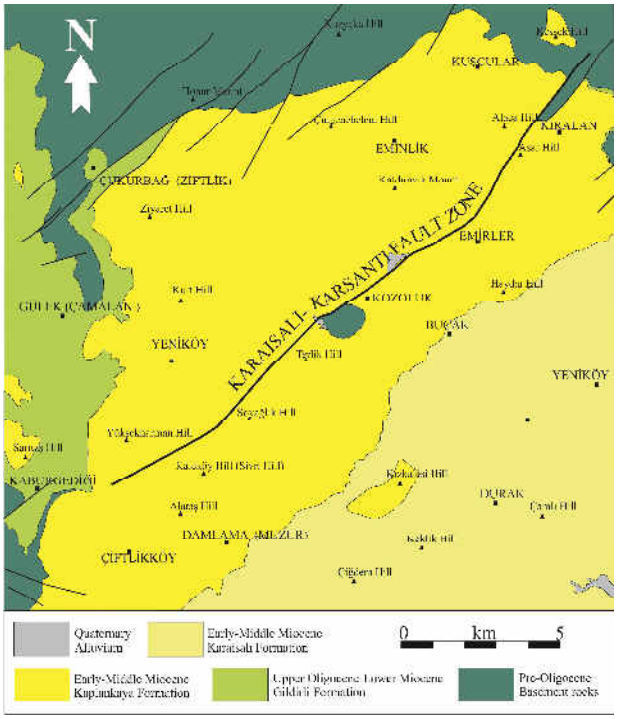

Fig. 3. Geological map of the study area (modified from [20]).

III. Method

Within the scope of this study field studies were conducted between Çiftlikköy and Kıralan villages that represents the central part of the NE-SW-trending Karaisalı-Karsantı Fault Zone. Structural and kinematic data that gathered during the observations directly along the fault planes were evaluated. 30 slip data in 3 fault plane stations were recorded in total. The data obtained were processed by FaultKin (v.7.6) software, and kinematic characteristics of the Karaisalı-Karsantı Fault Zone in the region were interpreted [20, 21].

IV. Results

The Karaisalı-Karsantı Fault Zone is composed of many fault segments formed at different lengths and directions along a line of approximately 120 km in the south of central Taurus and north of the Adana Basin. This fault is a significant structure for the neotectonics of southern Turkey. In this study conducted on the central part of the fault, fault plane was observed along the main topographic escarpment between Çiftlikköy and Kıralan. The fault cuts the Neogene aged units in the region and created various planes in N28-70E directions (Fig. 4). Northern side of fault planes display dense brecciation, carbonation and partial travertene formations (Fig. 4). Slope values of the planes were between 46-89° while rake values measured from slickensides are between 79-85°. It has been concluded that central part of the Karaisalı-Karsantı Fault Zone is not a pure left lateral strike-slip fault. Kinematic data and morphology indicate that the Karaisalı-Karsantı Fault Zone is a normal fault with a minor left-lateral component at least along its central part (Fig. 5).

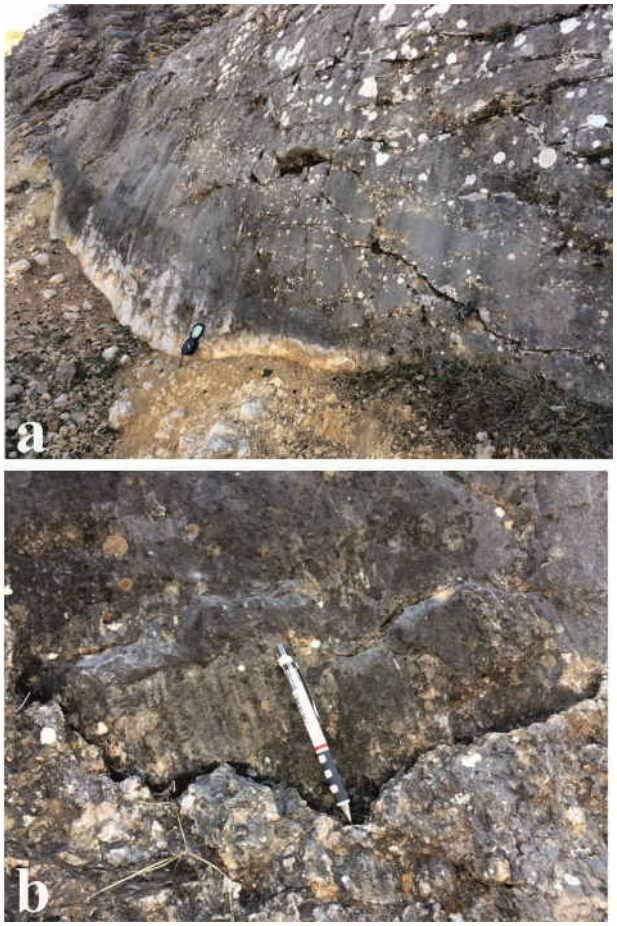

Fig. 4. Fault plane examples from the central part of the Karaisalı-Karsantı Fault Zone.

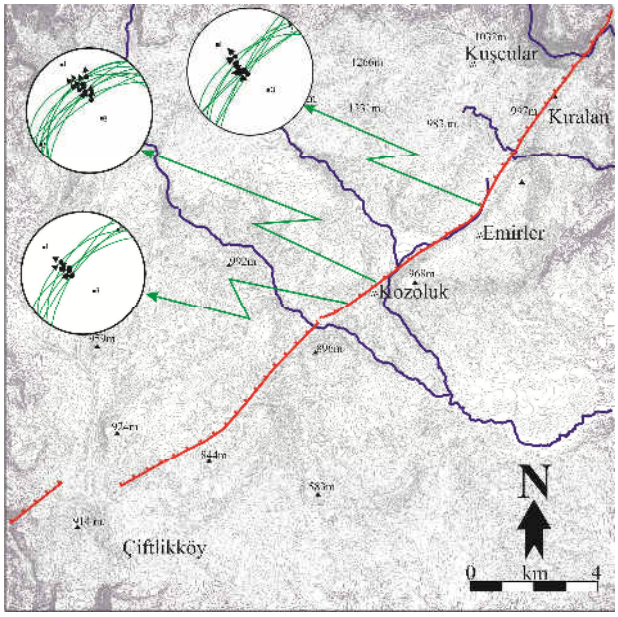

Fig. 5. Topography of the study area and fault plane data compiled from three stations along the central part of the Karaisalı-Karsantı Fault Zone.

V. Discussion and Conclusion

There are many fault zones located in southern Turkey. The Central Anatolian Fault Zone, the Karaisalı-Karsantı Fault Zone and the Karataş-Osmaniye Fault Zone are the most important of them. These are suggested as 'active' or 'potentially active' faults by previous authors [8, 10]. As mentioned previously, all these structures are defined majorly as left lateral strike-slip faults in literature [7]. This conclusion was drawn basing on mainly morphological and partly geological offsets. However, kinematic data remained limited particularly along the Karaisalı-Karsantı Fault Zone. According to our study, data gathered from fault planes which are exposed along the central part of Karaisalı-Karsantı Fault Zone indicate that the region's structure is slightly different than the previously suggested structure. Kinematic data collected from three stations between Çiftlikköy and Kıralan indicate that aforementioned section of the fault zone bears normal fault characteristics rather than suggestions of previous studies. A minor left lateral component is also observed. The mentioned fault zones control two densely populated areas of Turkey, Adana and Mersin cities (total population exceeds 3 million people). Therefore, it is necessary to obtain more detailed information about their characteristics and seismicities. Although the activity in the Quaternary period is not definite, the Karaisalı-Karsantı Fault Zone is defined as a 'potentially active fault' in the current literature as it cuts the carbonate rocks of Karaisalı Formation [7, 8, 10]. In order to clarify the activity statuses of the faults, it is very important to setting-up a local seismic station network to observe the faults and specify the seismicity of the region.

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VII. References

[1] McKenzie, D., 1972. Active tectonics of the Mediterranean region, Geophys. J. R. Astron. Soc., 30, 109–185.
[2] McKenzie, D., 1978. Active tectonics of the Alpine-Himalayan belt: the Aegean Sea and surrounding regions. Geophysical Journal International, 55 (1), 217-254.
[3] Şengör, A. M. C., Yılmaz, Y. 1981. Tethyan evolution of Turkey: a plate tectonic approach. Tectonophysics, 75, 181–241.
[4] Şengör, A. M. C., Görür, N., Şaroğlu, F. 1985. Strike-slip faulting and related basin formation in zones of tectonic escape: Turkey as a case study. In Biddle, K.T. and Christie-Blick, N. (Eds), Strike-slip Deformation, Basin Formation, and Sedimentation, Society of Economic Paleontologists and Mineralogists Special Publication 37, 227-264.
[5] Koçyigit A., Beyhan A., 1998. A new intracontinental transcurrent structure: The Central Anatolian fault zone, Turkey. Tectonophysics, 284, 317–336.
[6] McKenzie, D., 1976. The East Anatolian Fault: a major structure in eastern Turkey. Earth and Planetary Science Letters, 29 (1), 189-193.
[7] Şaroğlu, F., Emre Ö., Boray, A. 1987. Türkiye'nin Diri Fayları ve Depremsellikleri [Active faults and seismicity of Turkey] (394 p and 11 maps). General Directorate of Mineral Research and Exploration (MTA), Department of Geological Reseaches, Ankara (Open File Report).
[8] Şaroğlu, F., Emre, Ö., Kuşçu, İ. 1992. Türkiye Aktif Fay Haritası [Active Fault Map of Turkey]. General Directorate of Mineral Research and Exploration (MTA), Department of Geological Reseaches, Ankara.
[9] Bozkurt, E., 2001. Neotectonics of Turkey– a Synthesis."Geodinamica Acta", 14, p.3-30.
[10] İnan, S., Ekingen, S., 2007. Namrun Fay Zonu'nun jeolojik-morfotektonik özellikleri: Orta Anadolu Fay Sisteminin güneybatı bölümü (OrtaToroslar-Türkiye). Yerbilimleri, 28 (3) 147-158.
[11] 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 (90 p and One Sheet). MTA Special Publication Series, 30 [in Turkish and English].
[12] Görür, N., 1979. Karaisalı kireçtaşının (Miyosen) sedimantolojisi. Türkiye Jeoloji Kurultayı Bülteni, 22 (2), 227/234.
[13] Üşenmez, Ş., 1981. Belemedik (Pozantı-Adana) çevresinin jeolojisi. Selçuk Üniversitesi Fen Fakültesi Dergisi, A/1, 67-80.
[14] Özgül, N., 1984. Stratigraphy and tectonic evolution of the central Taurides. In: Geology of the Taurus Belt, Eds: Tekeli, O. and Göncüoğlu. M.C., 77-90, MTA, Ankara.
[15] Yalçın, M.N., Görür, N., 1984. Sedimentological evolution of the Adana basin, Tekeli, O. ve Göncüoğlu, M.C. (eds)., Geology of the Taurus Belt, Proceedings Int. Sym., 26-29 Eylül, 125-142, Ankara.
[16] Ünlügenç, U.C., Demirkol, C., 1988. Kızıldağ Yayla (Adana) dolayının stratigrafisi. Jeoloji Mühendisliği, 32-33, 17-25.
[17] Demirkol, C., 1989. The stratigraphy and geological development of the carbonate platform in the Pozantı-Karsantı-Karaisalı (East Taurus) area. Bulletin of Mineral Research and Exploration, 109, 33-44.
[18] Yetiş, C., Demirkol, C., 1984. Adana baseni kuzey-kuzeybatı kesiminin temel stratigrafisine ilişkin bazı gözlemler. TJK 38. Bilimsel ve Teknik Kurultayı Bildiri Özetleri, 59-61.
[19] MTA, 2011. Adana-N33 paftası, 1/100.000 ölçekli Jeoloji Haritası, Maden Tektik ve Arama Enstitüsü, Ankara.
[20] Marrett, R.A., Allmendinger, R.W., 1990. Kinematic analysis of fault-slip data. Journal of Structural Geology, 12, 973-986.
[21] Allmendinger, R.W., Cardozo, N.C., Fisher, D., 2012. Structural Geology Algorithms: Vectors & Tensors. Cambridge University Press, 289 pp. Cambridge.