Türkiye Jeoloji Bülteni **Cilt 50, Sayı 3, Aralık 2007**
Geological Bulletin of Turkey *Volume 50, Number 3, December 2007*

Lithostatigraphy and Mammalian Fossil Content of Lower Miocene Deposits in the Western Part of the Çankırı Basin: A Test for Post - Collisional Tectonic Models of NW Central Anatolia

Çankırı Havzası'nın Batı Kenarındaki Alt Miyosen Çökellerinin Memeli Fosil İçeriği ve Litostratigrafisi: KB İç Anadolu'nun Çarpışma Sonrası Tektonik Modelleri İçin Bir Test

Fatih ÖZCAN — Ankara University, Faculty of Eng., Dept. of Geol. Eng. Tectonics Research Group, 06100 Tandoğan. Ankara
Present address: Roketsan, Roket Sanayii ve Ticaret AŞ., 06780 Elmadağ, Ankara
Levent KARADENİZLİ — General Directorate of Mineral Research and Exploration, TR-06520 Ankara
Şevket ŞEN — Laboratorie de Palaeontologie Museum National d'Histoire Naturelle, 8rue Buffon, 75005, Paris, France
Gerçek SARAÇ — General Directorate of Mineral Research and Exploration, TR-06520 Ankara
Gürol SEYİTOĞLU — Ankara University, Faculty of Eng., Dept. of Geol. Eng. Tectonics Research Group, 06100 Tandoğan. Ankara
(gurol.seyitoglu@eng.ankara.edu.tr)

ABSTRACT

Detailed geological mapping of the western side of Çankırı basin demonstrates that the base of the Neogene succession, the Kılçak formation, is found on both sides of a tectonic sliver. These outcrops are correlated through their lithological descriptions and fossil contents. This finding eliminates the recent tectono-sedimentary model that presents the Kılçak formation as a last product of an intercontinental convergence, developed in front of the thrust sheets of the İzmir-Ankara suture zone. In contrast, our findings support the proposal that the Neogene succession in the western margin of the Çankırı basin is fragmented by the post Pliocene tectonic sliver, regarded as a neotectonic structure.

Key words: Çankırı basin, Kılçak, Neogene, Neotectonics, Mammalian fossils

ÖZ

Çankırı havzasının batı kenarında yapılan ayrıntılı jeolojik harita alımı, Neojen birimlerin tabanını oluşturan Kılçak formasyonunun bir tektonik kamanın her iki tarafında bulunduğunu ortaya çıkarmıştır. Bu formasyona ait yüzlekler, litolojik tanımlamaları ve fosil içerikleri ile deneştirilmektedir. Bu veriler Kılçak formasyonunu İzmir-Ankara kenet zonunda kıtalararası yakınlaşma sonucunda oluşan bindirmelerin önünde çökelen son ürün olarak değerlendiren tektono-sedimanter modeli yanlışlamaktadır. Buna karşılık aynı veriler, Pliyosen sonrasında oluşan bir neotektonik yapı olarak değerlendirilen tektonik kamanın Çankırı havzasının batı kenarını parçaladığı görüşünü desteklemektedir.

Anahtar Kelimeler: *Çankırı havzası, Kılçak, Neojen, Neotektonik, Memeli fosilleri*

INTRODUCTION

One of the largest Central Anatolian basins, the Çankırı basin, developed during the closure of the Neo-Tethyan ocean between the Sakarya continent and the Kırşehir block following Cretaceous to Eocene (Şengör & Yılmaz, 1981; Tüysüz et al. 1995; Erdoğan et al. 1996; Görür et al. 1998; Okay & Tüysüz, 1999) (Fig. 1). The post-collisional history of the basin is currently a debated issue (see Koçyiğit et al. 1995; Seyitoğlu et al. 1997; 2000; 2004; Kaymakçı, 2000; Kaymakçı et al. 2001). The conflicting views can be summarized in three groups. The first view suggests that intracontinental convergence due to the closure of Neo-Tethyan Ocean continued until the Late Pliocene, the Ankara Orogenic Phase of Koçyiğit et al. (1995). The second view proposes that this convergence ended after the Early Miocene and extensional tectonics become dominant during Middle Miocene. The following transpressional regime has been proposed for post- late Miocene times (Kaymakçı, 2000; Kaymakçı et al. 2001). The third view claims that pre-Neogene intracontinental convergence gives way to the Early Miocene extensional regime. After the late Pliocene, a tectonic sliver, named the Eldivan-Elmadağ Pinched Crustal Wedge (EPCW), fragments the Neogene Çankırı basin due to NW-SE compression that is believed to be created by the interaction between the North Anatolian Fault and its splay Kırıkkale Erbaa Fault (Seyitoğlu et al. 1997; 2000; 2001; 2004; Karadenizli et al. 2003; Savaşçı & Seyitoğlu, 2004) (Fig. 1).

Our team produced detailed geological mapping on the Lower Miocene units in the western margin of the Çankırı basin. The distribution of these units is very important in order to test the regional tectonic models summarised above, because the base of the Neogene succession, particularly the Kılçak formation is evaluated as a last product of intercontinental convergence due to its position in front of the thrusts in the western Çankırı basin (Kaymakçı 2000; Kaymakçı et al. 2001). Alternatively, if the post-late Pliocene tectonic sliver model (Seyitoğlu et al. 2000; 2004) is correct then the fragmented lower Miocene units would be common features in the region.

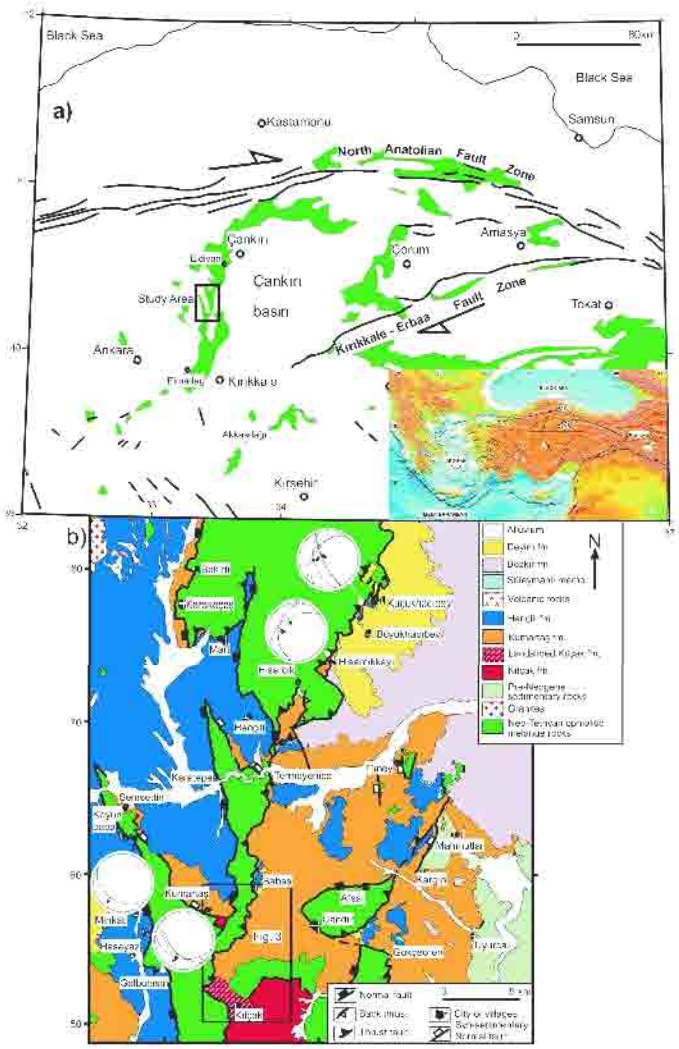


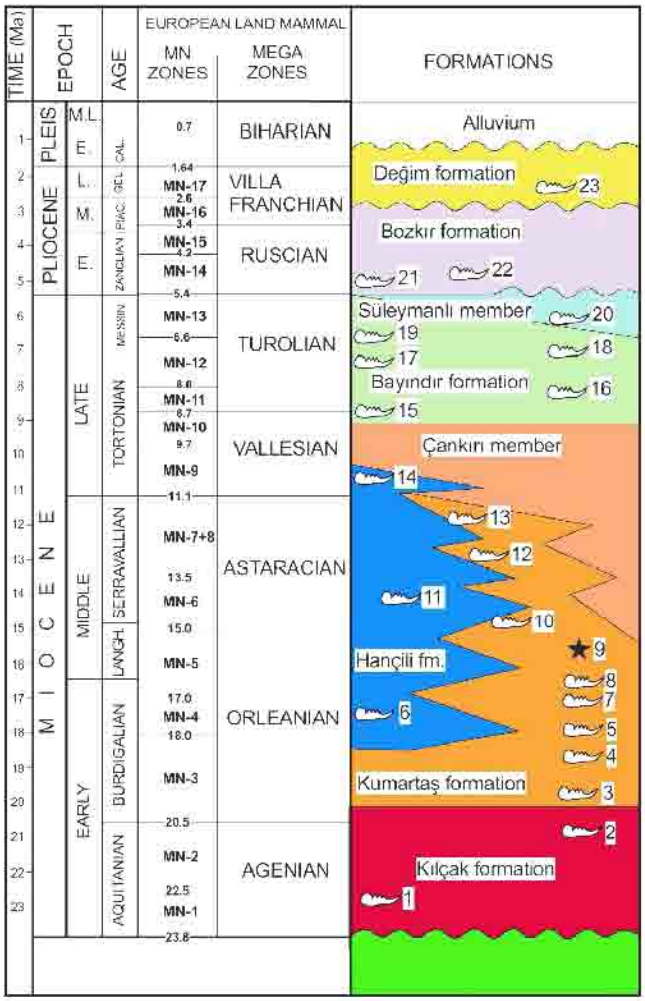
Figure 1. (a) The main neotectonic elements of Central Anatolia. Grey areas represent the Neo-Tethyan Suture zone. (b) Geological map of the western margin of Çankırı basin. Schmidt lower hemisphere equal area projections belong to the normal faulted western, thrusted eastern margin of the Elmadağ-Eldivan Pinched Crustal Wedge. Great circles and arrows are fault surfaces and striations respectively.

Şekil 1. *(a) İç Anadolu'nun ana neotektonik elemanları. Gri alanlar Neo-Tetis kenet zonunu temsil etmektedir. (b) Çankırı havzası batı kenarının jeolojik haritası. Schmidt alt yarıküre eşit alan projeksiyonları Eldivan-Elmadağ tektonik kamasının batı kenarındaki normal faylara ve doğu kenarındaki bindirme faylarına aittir. Büyük daireler fay düzlemlerini oklar ise fay çiziklerini göstermektedir.*

This paper presents the stratigraphical relationship between the Kılçak and Kumartaş formations and the geological map of Kılçak outcrops with their fossil content. The tectonic meaning of our findings will also be discussed.

NEOGENE STRATIGRAPHY OF ÇANKIRI BASIN

The Neogene stratigraphy of Çankırı basin starts with the Kılçak formation (Fig. 2). Its fossil content indicates MN 1-2 zones (Hoek Ostende, 1992; 1995a&b; Bruijn & Saraç, 1992; Bruijn et al. 1993; Ünay, 1994; Bruijn & Koenigswald, 1994; Şen et al. 1998) and was first recognised as a separate lithological unit by Şen et al. (1998). The type section of the Kılçak formation (Kaymakçı, 2000; Kaymakçı et al. 2001) shows a fining upward character and is composed of conglomerate, and an alternation of sandstone, shale, siltstone, marl, limestone, lignite and mudstones. The base of the formation is not observed due tectonic contacts and no contact relationship has been reported with the younger Kumartaş formation (Şen et al. 1998; Kaymakçı 2000; Kaymakçı et al. 2001). The Kumartaş formation was determined by Akyürek et al. (1980) and is composed of red conglomerate, sandstone and mudstone. The Early Late Miocene age (MN 3-9) has been ascribed to the Kumartaş formation and its Çankırı member. Both the fossil content of the different localities and the detailed stratigraphical loggings indicate that the Kumartaş formation interfingers with the Hançili formation (Karadenizli et al., 2004). The Neogene stratigraphy continues with Late Miocene yellowish evaporitic Bayındır Formation and its flood plain deposits of Süleymanlı member containing red mudstones. They are overlain by the Pliocene Bozkır formation, which has white gypsum and mudstones (Varol et al. 2002). The Upper Pliocene- Pleistocene



23: Sarıkaya
22: Kavurca
21: Tepealagöz
20: Süleymanlı
19: Steel door factory
18: Çankırı Cemetery
17: Traffic Police station
16: Çorakyerler
15: Tuğlu
14: Çapar
13: Mahmutlar
12: Gökçeören
11: Hıdırlık
10: Çandır
9. Çaparkayı (15.7 Ma K-Ar)
8: Karakoçaş
7: Hisarcık
6. Hançili
5: Şemsettin
4. Babaş
3 Kumartaş
2 Sülüklü göl
1: Kılçak

Figure 2. Neogene stratigraphy of Çankırı basin with the mammalian fossil locations (from Karadenizli et al. 2004, MN & Mega Zones from Steininger 1999).

Şekil. 2. *Çankırı havzasının Neojen stratigrafisi ve memeli fosil yerleri (Karadenizli vd. 2004'ten alınmıştır. MN & Mega Zonlar Steininger 1999'a aittir.)*

Deyim formation unconformably covers the oldest sedimentary units in the basin and is composed of conglomerates, sandstones and mudstones (Karadenizli et al., 2004) (Fig. 2).

FIELD OBSERVATIONS ON LOWER MIOCENE SEDIMENTARY SUCCESSIONS IN THE KILÇAK-KUMARTAŞ AREA, WESTERN ÇANKIRI BASIN

We discovered a sedimentary unit around Sülüklügöl whose composition was dominated by claystone, marlstone with conglomerate, sandstone and lignite layers (Fig. 3). This unit conformably underlies the Kumartaş formation. The detailed lithological descriptions (Özcan, 2003) and the fossil content *Galerix* sp., *Soricidae* indet., *Albertona* n.sp., *Ctenodactylidae* indet, *Debruijnia* sp., *Spanocricetodon* sp., *Democricetodon* sp., *Megacricetodon* sp., *Cricetodon versteegi* - (MN 1-3, Karadenizli et al., 2004) securely correlates the Sülüklügöl unit with the Kılçak formation that its type section measured (Kaymakçı 2000) near the Kılçak village (Fig.4). It is obvious that the newly recognised sedimentary unit in the Sülüklügöl area is equivalent to the Kılçak formation (see also Özcan et al. 2006). The geological map of the area (Fig. 3) indicates that the Kılçak formation outcrops in two places (i.e. Sülüklügöl and Kılçak), separated by the tectonic contacts of Neo-Tethyan ophiolitic melange rocks. Detailed field observations are able to distinguish syn - and post -sedimentary faulting.

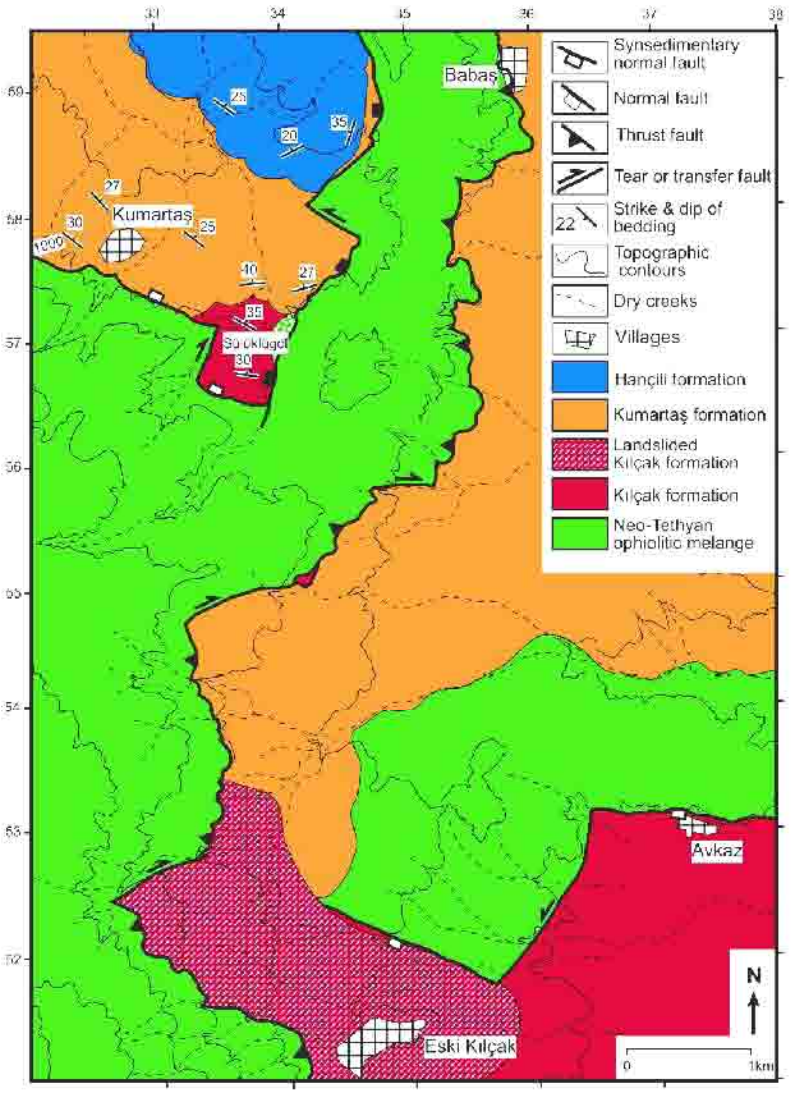


Figure 3. Geological map of Kumartaş-Kılçak area.

Şekil 3. *Kumartaş Kılçak arasının jeoloji haritası.*

Syn-sedimentary faulting: a NW-SE trending syn-sedimentary faulting in the area has been documented by Savaşçı (2003), Karadenizli et al. (2003) and Savaşçı & Seyitoğlu (2004), demonstrating the establishment of extensional tectonics during the Early Miocene times. Karadenizli et al. (2003) also suggested the existence of intra-basinal highes acting as half graben shoulders during the deposition of the Kumartaş and Hançili formations. In the study area, southeast continuations of Savaşçı & Seyitoğlu's syn-sedimentary faults "A & B" (2004; Fig. 3) are located to the southwest of Kumartaş village (Fig. 3) and probably control also the deposition of the Kılçak formation, but we have no direct evidence of this. It is clear that these syn-sedimentary faults are cut by the younger faults of EPCW.

Post-sedimentary faults of EPCW: Our detailed field observations demonstrate that the Kılçak formation outcrops on both sides of the NNE trending tectonic wedge of the Neo-Tethyan ophiolitic melange rocks-EPCW (Seyitoğlu et al. 2000; 2004), (Fig. 3). The eastern margin of EPCW thrusted onto the Kılçak, Kumartaş and Hançili formations in the study area. Along this thrust zone there is no sedimentary evidence in these formations, indicating syn-sedimentary movement of the thrust sheets. Instead, we observed highly sheared fine grained sandstone and mudstones of the Kılçak formation, demonstrating post depositional movement of the EPCW.

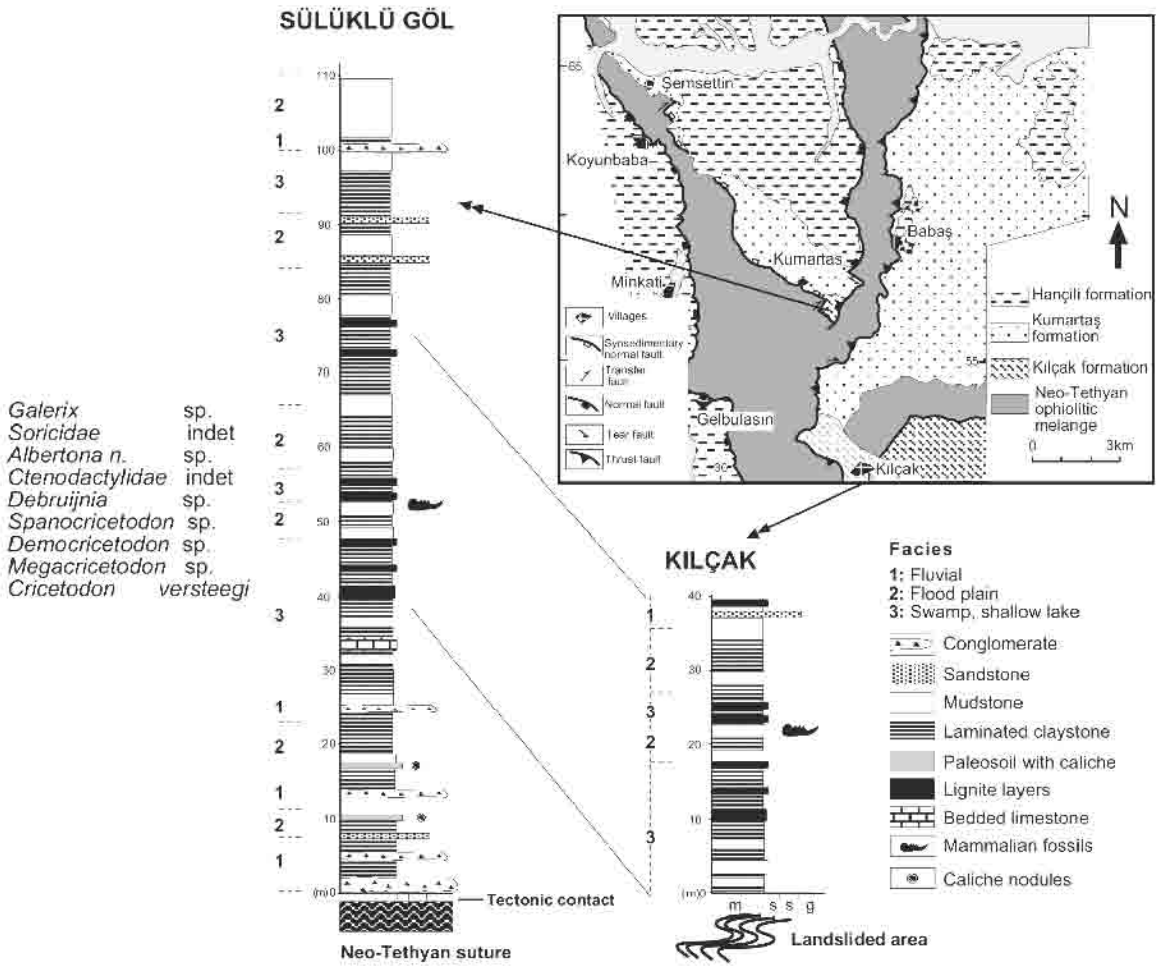


Figure 4. Measured stratigraphical column of Sülüklügöl and Kılçak localities with fossil content (from Özcan 2003 and Karadenizli et al. 2004).

Şekil 4. *Sülüklügöl ve Kılçak lokalitelerinin ölçülü stratigrafik kesitleri ve fosil içeriği (Özcan 2003 ve Karadenizli vd. 2004).*

Kılçak, Kumartaş and Hançili formations are also cut by a normal fault that constitutes the western side of the EPCW (Fig. 3), similar to the en-echelon counterparts of the previously examined Karatepe and Koyunbaba normal faults (Savaşçı & Seyitoğlu, 2004; Önal et al. 2006).

Taken together, this evidence indicates that the Kılçak formation is not accumulated in front of thrust sheets as suggested by Kaymakçı (2000) and Kaymakçı et al. (2001), but is fragmented by a post - early Pliocene tectonic wedge (EPCW), like other Mio-Pliocene sedimentary successions in the western part of the Çankırı basin (Seyitoğlu et al. 2000; 2004).

DISCUSSION AND CONCLUSION

The post - orogenic tectonic development of the Neo-Tethyan suture in NW central Anatolia is currently a debated issue. Koçyiğit et al. (1995) suggest that intercontinental convergence after the closure of the Neo-Tethyan suture continued until the Pliocene "Ankara Orogenic Phase". Following the Pliocene, a non-compressional tectonic regime has been attributed to the region. Seyitoğlu et al. (1997) questioned the "Ankara Orogenic Phase" on the basis of field observations (see Seyitoğlu et al. 2006 for a recent paper on this subject) and the volcanic evolution of the Galatian volcanics, and suggested Miocene extension due to orogenic collapse in the region. Later, Bozkurt et al. (1999), basing his argument on geological setting and isotopic dating of the volcanic rocks near Ankara, admitted that the intercontinental convergence ceased in Early Miocene. However, Kaymakçı (2000) suggested that the compressional regime continued until Middle Miocene and that the Kılçak formation accumulated in front of the east vergent thrusts created by indentation of the Kırşehir block into the Sakarya continent. Although the upwards-fining character of the Kılçak formation has been given in the type section, the formation is interpreted as a latest product of the compressional regime (Kaymakçı, 2000; Kaymakçı et al. 2001). Kaymakçı (2000) proposed an extensional regime for the region during the Middle Miocene, and claimed a paleohigh bounded by normal faulting, that caused the development of different stratigraphies in different basins, namely the Hançili and Çankırı basins. While the Kumartaş and Hançili formations are believed to accumulate in the Hançili sub-basin, the Çandır, Süleymanlı and Bozkır formations developed in the Çankırı basin. This paleohigh is thought to be reactivated as double vergent thrust faults with a strike-slip component due to transpression following the Late Miocene (Kaymakçı, 2000; Kaymakçı et al. 2001).

However, instead of the double vergent thrusting, Seyitoğlu et al. (2000; 2004) documented that EPCW fragments an existing Neogene sedimentary unit of the Çankırı basin following the Late Pliocene. This NNE trending tectonic sliver, having a normal fault relationship with the sedimentary units on its western margin, but with an eastern margin thrusting onto the Neogene succession, developed between Çankırı and Ankara as a result of a NW-SE contraction created by the North Anatolian Fault and its splay Kırıkkale Erbaa Fault (Seyitoğlu et al. 2000; 2004).

The cropping out of the Kılçak formation on both sides of EPCW, documented in this paper, supports the contention of Seyitoğlu et al. (2000; 2004) that the Neogene units at the western margin of the Çankırı basin are fragmented by EPCW following Late Pliocene.

ACKNOWLEDGEMENTS

This paper is one of results of projects sequentially supported by TUBITAK (198Y014), Ankara University (20010705053), TUBITAK-CNRS (101Y108), CNRS-INSU (ECLIPSE), MTA 16-A3.

GENİŞLETİLMİŞ ÖZET

Çankırı havzası İç Anadolu'nun önemli sedimanter havzalarından biri olup, kıtalararası yakınlaşma sonrası havzanın Neojen'deki tektonik gelişimi üzerine tartışmalar sürmektedir.

Çankırı havzasının batısında Kaymakçı (2000) ve Kaymakçı vd. (2001) tarafından öne sürülen tektono-sedimanter modele göre Alt Miyosen Kılçak formasyonu, kıtalararası yakınlaşma nedeniyle oluşan bindirmelerin önünde çökelmiştir. Orta Geç Miyosende Çankırı havzasını alt havzalara böldüğü düşünülen normal faylarla sınırlı paleo yükselti, Hançili kenar havzasında Kumartaş ve Hançili formasyonlarının, Çankırı havzasında ise Çandır, Süleymanlı ve Bozkır formasyonlarının çökelimine neden olmuştur. Bölgede Üst Miyosenden itibaren geliştiği öne sürülen yanal sıkıştırmalı rejim, paleoyükseltiyi sınırlayan normal fayların ters faylar

olarak çalışmasını sağlayarak Neo-Tetis kenet zonu kayaçlarının Neojen birimler üzerine bindirmesini gerçekleştirdiği belirtilmiştir (Kaymakçı, 2000; Kaymakçı vd. 2001).

Bu tektono-sedimanter model, arazi gözlemlerimizle uyumlu değildir. Ankara ve Çankırı arasında tanımlanan batı kenarı normal faylı, doğu kenarı bindirmeli Elmadağ-Eldivan tektonik kaması, Geç Pliyosen'den sonra Çankırı havzasının Neojen çökellerini parçalamıştır (Seyitoğlu vd. 2000; 2004). Bu makalede, Kılçak formasyonunun Eldivan-Elmadağ tektonik kamasına ait bindirmelerin batısında da yeraldığına ait veriler Sülüklügöl civarındaki sedimanter birimlerin litolojik tanımlamaları ve paleontolojik verilerinin Kılçak formasyonunun ilk tanımlandığı Kılçak çevresindeki birimlerle yapılan karşılaştırma sonucu ortaya konmuş olup, bu Kaymakçı (2000) tarafından öne sürülen modeli yanlışlayan en önemli verilerden biri olarak görülmektedir. Eldivan-Elmadağ tektonik kamasının her iki tarafında Kılçak, Kumartaş ve Hançili formasyonlarının bulunuyor olması, Çankırı havzasının Erken Orta Miyosende birbirlerinden izole alt havzalara ayrılmadığını, kıtalararası yakınlaşmanın Erken Miyosenden önce sona ermesi gerektiğini göstermektedir.

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Makale Geliş Tarihi : 6 Ocak 2007
Kabul Tarihi : 12 Temmuz 2007

Received : *January 6, 2007*
Accepted : *July 12, 2007*