International Earth Sciences Congress on Aegean Regions,
1990, Abstracts, İzmir, s.201-202.

STRUCTURAL EVOLUTION OF THE EASTERN TAURUS IN THE CRETACEOUS - TERTIARY PERIOD

Ali YILMAZ and Evren YAZGAN
MTA, Department of Geology, Ankara-TURKEY

The Eastern Taurus, which is in the Alpine Orogenic Belt, is extending from the Ecemiş fault in the west, up to the Central Iranian and Sanandaj-Sirjan Belts further in the east, bounded by the Cimmerian Continent to the north and the Arabian Continent to the south.

This region consists of the units showing continental, platform, oceanic and island-arc type environmental characteristics. These units have been juxtaposed before the Upper Maestrichtian. There is no data indicetive of formation or preservation of any oceanic crust during and after the Upper Maestrichtian, it can be concluded that the ophiolite as well as the continent-island-arc-continent collision occured before the Upper Maestrichtian.

In the region the Upper Maestrichtian-Tertiary units show the characteristics presented below: 1- density of local and regional unconformities, 2- marked variations of lateral or vertical sedimentary facies, 3- data of simultaneous development of both extensional and compressional tectonics within the same basins, 4- absence or local existance of metamorphism due to local tectonics, 5- rare magmatic activity and related imtracratonic volcanism, 6- a tendency for longitudinal as well as lateral basin asymmetry. These features in general represent environments developed under the control of strike-slip/oblique fault systems in the stage followed by continent -continent collision. The active tectonic structures of today can be proposed to be formed under the control of tectonic activity prevailing since the Maestrihtian, that is to say it may have been directed by paleotectonics.

On the other hand, if the displacement rates of the Arabian-African continent relative to the European continent are considered, the apparent decrease in

the rate of convergence in the Upper Campanian -Maestrichtian time may be said to be a result of continent-continent convergence and collision. Particularly at the end of Eocene, the collision rate has been acclerated and the Red Sea basin began to develop as an impactogene, because of the velocity reactivation. When the opening of the Red Sea and timing of compressional events in Eastern Anatolia are compared, it can be concluded that the opening of the Red Sea has been controlled by the compressional events prevailed in the Eastern Anatolia.

Yılmaz, A. ve Yazgan, E., 1990, Structural Evolution of the
Eastern Taurus in the Cretaceous-Tertiary Period:
IESCA, Proceedings, no 2, İzmir, 345-356.

STRUCTURAL EVOLUTION OF THE EASTERN TAURUS IN THE CRETACEOUS - TERTIARY PERIOD

Ali YILMAZ and Evren YAZGAN
MTA, Department of Geology, Ankara - TURKEY

ABSTRACT: The Eastern Taurus of the Alpine Oregenic Belt extends from the Ecemiş fault in th west to the Sanandaj Sirjan Belt to the east. It is bounded by the Pontian Belt to the north and Arabia Continent to the south.This region consists of rock units deposited at continental, platform, oceanic and is land arc environments. These units are overthurst to each other and juxtaposed before the Lat Maastrichtian. There is no data showing the existence of any relict oceanic basins during and after the Lat Maastirichtian. Henceforth, it can be concluded that the ophiolites as well as continent - continent collisio occured before the Late Maastrichtian. On the basis of sedimantry, tectonic, metamorphic, magmatic an volcanic features, it can be concluded that the Upper Maastrichtian - Tertiary cover shows environment developed under the control of strike - slip / oblique faulting prevailed after the continent - continent colli sion. The Neotecnic structures of today can be proposed to be formed under the control of tectonic activit prevailing since the Maastricihtian, that is to say it might have been controlled by paleotectonics. On th other hand, regional tectonic geological evaluations within regional framework, it can be suggested tha the Red Sea began to develop as an impactogene after the paroxysm of the collision in Oligocene Miocene time.

INTRODUCTION

The Eastern Taurus segment of the Alpine Orogenic Belt, runs in approximately WSW-ENE directio and is sited between the North Anatolian Ophiolitic Belt in the north and Arabian Plate in the South (Fig 1) In the Tauride Belt, different tectonic units are exposed and they consist of continental, platform oceanic and island arc type of rocks assamblages. According to the previous studies, continent - arc o continent - continent collisions occured at the end of Cretaceous (Michard et al, 1985; Yazgan, 1987), a Eocene - Oligocene (Michard et al, 1985; Akay;1989) or Middle Miocene epoches (Şengör, 1980; Şengö et al., 1985; Dewey et al. , 1986). Cretaceous-Tertiary structural evolution of the area was interpreted i different ways by Adamia et al. (1980), Şengör and Yılmaz (1981), Yazgan (1984), Michard et al. (1985) Aktaş and Robertson (1985, 1990). These different evolutionary models are caused by either the lack o data or the methods used to evalute the data. The purpose of this study is to describe Late Cretaceou (mostly Maastrichtian)-Tertiary the structural evoution of the Eastern Taurus Belt.

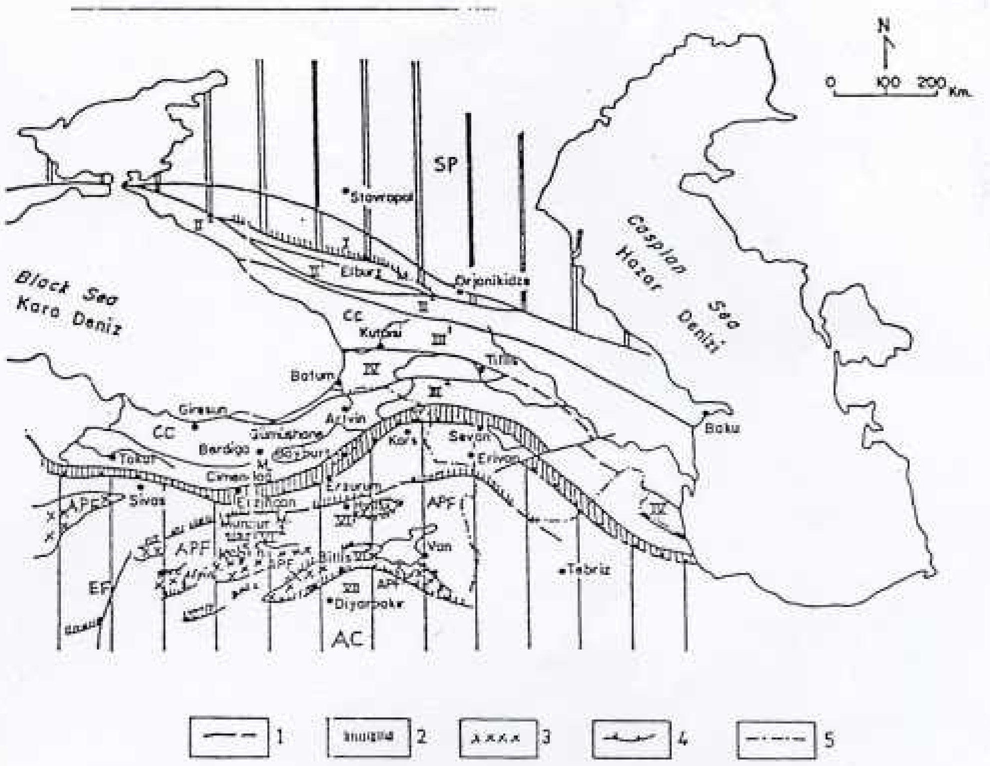


Fig. , 1, The study area within the regional framework (After International Geological Congress xxvii Session, Guidebook, 1984 and Yılmaz, 1989).

I- Laba - Malka Zone of the Greater Caucasus; II[1] Main Range Zone of the Greater Caucasus; II[2] Southeren Slope Zone of the Greater Caucasus; III[1] .. Gagra-Djava Zone and northern part of the Transcaucasus; IV - Black Sea Coastal Zone/Adjara-Trialetian and Talysh Zones; III[2]- Pontian Zone/ Somcheti-Kafan (Karabakh) Zone of the Transcaucasus (The southern part of the Cimmerian Continent) V - Northern Anatolian Ophiolitic Belt/The Lesser Caucasian Ophiolitic Belt. VI - The Eastern Taurus Belt/ The Iranian quasiplatform of the Lesser Caucasus: Miskan-Zangezur and Araks Zones VII- The northern part of the Arabian Continent.

1 - Approximate borders of the tectonic zones, 2-Ophiolitic Zones, 3 - The metamorphic massifs, 4- Major overthrusts, 5-Borders of the states

Abbreviations: AC, the Arabian Plate; APF, the Arabian Platform Fragments; CC, the Cimmerian Continent; EF, the Ecemiş Fault; SP, the Scythian Platform.

DESCRIPTION OF THE TECTONIC UNITS

The Eastern Taurus Belt, is divided into zones of dissimilar tectonic, sedimentologic and magmatic histories (Fig., 1,2). These zones are made of platform, oceanic and island-arc type of the rock assemblages thrusted onto each other before Late Maastrictian (Fig., 2).

In Turkey, The Cimmerian Continent (Şengör, 1979, 1984) extending to the north of the Eastern Taurus Belt is known as the Pontian Zone (Ketin 1966). The southern margin of this continent was formely interpreted as an south facing Atlantic type continental margin during in the Jurassic-Lower Cretaceous and as an north facing during island arc Late Cretaceous (Yılmaz, Y., 1980; Şengör and Yılmaz, 1981). Main characteristic of this margin is a local unconformity between the Pre-Maastrichtian and Maastrichtian rocks (Terlemez and Yılmaz, 1980). In contrast, there are no island arc type of volcanics of Maastrichtian- Paleocene times. The Eocene and younger volcanics of the region were interpreted as the products of an intracratonic volcanic activity (Terzioğlu, 1984, 1985 a, b; 1986 a,b, 1987).

In the North Anatolian-Lesser Caucasus Belt, The Jurassic-Lower Cretaceous ophiolites of oceanic ridge origin (Yılmaz ,A., 1980,1981; Buket, 1982; Zakariadze et al.,1983) and the Upper Cretaceous ophiolites of island arc-marginal sea origin (Bektaş, 1981; Zakariadze et al, 1983) were mixed to each other by the tectonic processes. The ophiolites and melanges altogether were obducted onto the Lesser Caucasus during pre-Late Coniacian (Gasanov,1986) and onto the eastern part of the North Anatolian Ophiolitic Belt during pre-Late Campanian (Yılmaz, 1982). The Upper Coniacian-Upper Campanian molassic rocks unconformably overlie the ophiolites and melanges .

In the Eastern Taurus belt, main tectonic units are the Munzur Platform, the Keban-Malatya Metamorphics, the ensimatic-arc assamblage and the Bitlis-Pütürge Metamorphics (Fig,2). Tectonic juxtaposition of these units can be explained different ways. But, it is obvious that the ophiolites and the ensimatic arc association were obducted and then juxtaposed before Late Maastrichtian. In the northeastern part of the Munzur Mountains, around the Tecer area, the Upper Maastrichtian clastics and neritic limestones unconformably overlie both ophiolites and the Munzur Platform type carbonates (Özgül, 1981; Aktimur et al, 1988). The Kemaliye formation representing an olistostromal melange in Campanian age lies between the Munzur Platform and Keban-Malatya metamorphics (Özgül, 1981; Özgül and Turşucu, 1984). In addition, around the Malatya area, the Upper Maastrichtian clastics overlie the Keban-Malatya metamorphics and the ensimatic- arc association known as the Yüksekova unit (Perinçek, 1979, 1980) or İspendere- Kömürhan to the Baskil units (Yazgan, 1984). The Maastrichtian clastics also overlie the Bitlis Metamorphics(Göncüoğlu and Turhan 1983), and the Akdağ Metamorphics and ophiolites in Eastern Anatolia (Yılmaz et al, 1990). The Bitlis Metamorphic rocks may be interpreted as metamorphic equivalent of the northern Arabian Plate (Çağlayan et al. , 1984).

Along the northern part of the Arabian Plate, some ophiolitic units derived from the southern branch of the Neo-Tethyan ocean are exposed (Şengör and Yılmaz, 1981). This association known as the Koçali Unit (Perinçek, 1979) was derived from the ophiolites to the north of the Bitlis-Pütürge fragment. The ophiolitic units are overlain unconformably by a post tectonic sedimentary cover of Upper Maastrichtian-Tertiary deposits.

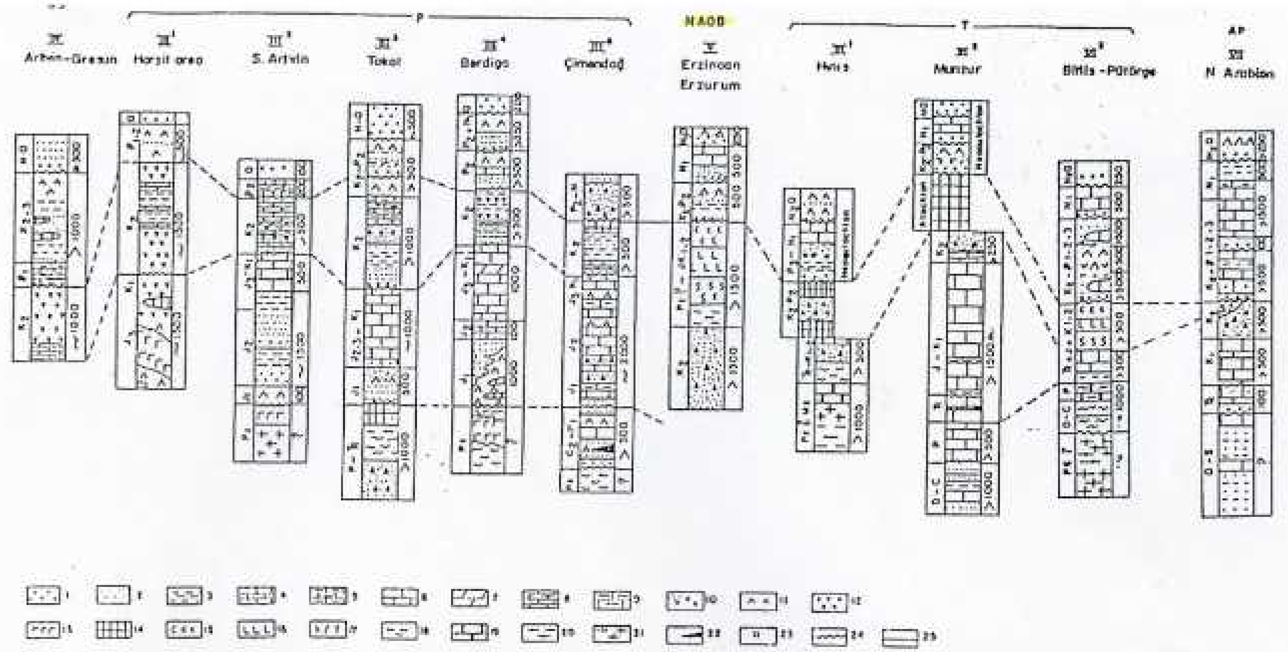


Fig., 2, Generalized coloumnar sections of the tectonic belts from northeastern Turkey; Explanations: BS, Black Sea Coastal Zone; P, Pontian Zone; NAOB, Northern Anatolian Ophiolic Belt; T, Taurus Zone; A, Arabian Continent.

IV- The area between northern Artvin and Giresun (After Akıncı, 1982; Altun, 1984); III[1] - Giresun Herşit area (After Gedikoğlu, 1978, Özsayar et al,1981); III[2]- Artvin area and southern (After Baydar et al., 1979; Şengör et al., 1980); III[3]- Tokat area (After Öztürk, 1979; Yılmaz, 1981,1983); III[4]- Gümüşhane- Berdiga area (After Nebert, 1961, Yılmaz, Y., 1972; Pelin, 1977); III[5]- The area between Çimendağ-Bayburt (After Akdeniz, 1984;Yılmaz, 1985); V- The area between Erzincan-Erzurum (After Bergougnan, 1976; Tatar, 1978; Buket, 1982; Bektaş et al, 1984; Yılmaz, 1985); VI[1]- Erzurum- Hınıs area (After Yılmaz et al., 1988,1990); VI[2]- The Munzur Mountains area and south-western of it (After Özgül, 1981, Metin et al., 1986; Sümengen and Terlemez, 1986); VI[3]- The Bitlis-Pütürge area (After Yazgan, 1983; Çağlayan et al., 1984; Göncüoğlu and Turhan, 1984); VII- The northen part of the Arabian Continent (After Perinçek, 1979; Yazgan, 1983).

1- Conglomerate, 2-Sandstone, 3- Claystone, 4- Sandy limestone, 5- Clayey limestone, 6- Reefal limestone, 7-Dolomite, 8- Deep marine limestone, 9- Chert, Cherty limestone, 10- Ophiolitic olistostrome, 11- Shallow marine and subaerial lavas, 12- Deep marine Volcanics, 13- Intrusive rocks (between granite and syenite), 14- Tectonic melange , 15-Ophiolitic volcanic complex, 16- Gabbro-diabase-diorite complex, 17-Ultrabasics, 18- Phyllite and schist, 19-Marble, 20- Amphibolite,21- Micaschist and gneiss, 22- Coal seams, 23- Gypsum and halite,24- Unconformities, 25- Tectonic contacts.

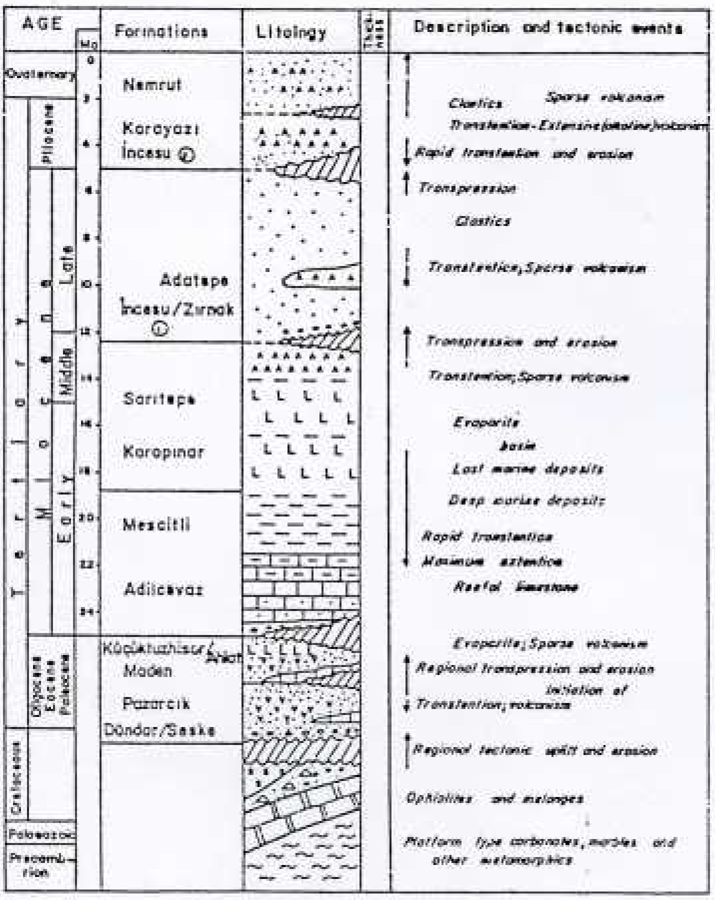
In general, the tectonic contacs separating the above-mentioned units are generally north-vergent. In contrast, south-vergent contacts are also observed, in places.

POST TECTONIC COVER

Previously described tectonic units are unconformably overlain by a post- tectonic volcano-sedimentary cover of Late Maastrichtian- Tertiary age. Furthermore there is no data showing formation and preservation of any oceanic crust during or after Late Maastrichtian. So Continent- Continent collision has to be occured before Late Maastrichtian in this region.

Now it will be useful to look at the generalized and simplified coloumnar section showing the stratigraphic and tectonic data of the Upper Maastrichtian- Tertiary sequence in the Eastern Taurus belt along the Central and Eastern Anatolia (Fig.3). After Late Maastrichtion a regional tectonic uplift and erosion took place in the region. The cover is composed of the alternation of transgressive and regressive sequences (Yılmaz et al 1988, 1990; Yazgan, 1987; Akay, 1989). In this unit, there is a density of local and regional unconformities. In addition lateral or vertical variations of sedimentary facies are commen in the unit. The unconformities represent transpressional, whereas volcanic levels represent transtentional stages. The stages of transtentions and transpression alternate. There is no metamorphism of the Upper Maastrichtian-Tertiary sequence except for slight metamorphism due to local tectonics. For instance, the Eocene Maden Volcanics which show only local metamorphism along the major overthrusts. On the other hand, these volcanics have been interpreted as the products of ensimatic island- arc tholeiites (Erdoğan, 1977; Özçelik, 1985) or the products of intracratonic subduction (Yazgan, 1983). Similarily, according to Gökten and Floyd (1987) the Paleocene Şarkışla volcanics are an andesite- dominated suite of calc-alkali lavas, probably developed adjacent to an active continental margin in a local (ensialic back-arc ?) basinal area. In fact, all these volcanics were formed after regional tectonic uplift and erosion of the tectonic units and the cover, and may represent transtentional phase of the intracraton as well. The Eocene Kösedağı volcanics (Kalkancı, 1974), and the Tertiary volcanics of the Pontian Zone (Terzioğlu, 1984, 1987) have been interpreted as intracratonic volcanics. Geochemically, the same volcanics may be interpreted in different way. So, the setting of the volcanics must be regarded as a whole, then geochemical methodes should be used. In addition, there is a tendency for longitudinal as well as lateral basin asymetries of the Maastrichtian- Tertiary basins. Forexample, Sivas, Pasinler, Tekman-Karayazı, Hınıs (Yılmaz et al., 1988,1990) Muş (Akay, 1989), Maden (Yazgan, 1983, 1987) basins show longitudinal as well as lateral basin asymetries and developed under the tectonic control of lateral fault systems.

The general features of the cover presented above, indicate environments developed under the control of strike-slip/ oblique fault systems (Reading, 1980, Christie-Blick and Biddle, 1985) in the stages following the continent- continent collision. The active tectonic structures of today can be proposed to be formed under the control of the older tectonic activity which prevailing in the area since the Maastrichtian, that is to say, they might have been directed by Paleotectonics.



Fig; 3, Generalized geologic column showing stratigraphy and tectonic events of the Eastern Taurus Belt along the Eastern and Central Anatolia (After Yılmaz et al., 1988 and 1990; Yazgan, 1988; Akay, 1990).

THE EASTERN TAURUS BELT WITHIN THE PLATE TECTONIC FRAMEWORK

The Eastern Taurus Belt represents a collision zone between the Cimmerian and the Arabian Continents. Collisional effects are seen on both continents. These effects have been interpreted in different ways previously. According to McKenzie (1972), after the opening of the Red Sea and the subsequent northward movement of the Arabian continent, the collision began in Miocene times. This model was supported later also by Şengör (1980). On the other hand, according to Michard et al. (1985), Akay (1989) Aktaş and Robertson (1990), the collision must have occured in the late Eocene- Oligocene times. In thes cases, McKenzie's (1972) model is not valid. In addition, Michard et al (1985) and Yazgan (1987) suggested that the collision must have occured at the end of Cretaceous. According to our results, the collision should have occured in Pre-Upper Maastrichtian times. The generalized columnar section indicating the stratigraphic and tectonic features of the Red Sea area (Fig., 4) is useful for correlating general stratigraphic and tectonic features of both the Red Sea and the Eastern Taurus Belt. According to Evans (1983), Miller and Barakat (1988) in the Red Sea area (Fig.,4), there is a granitic basement and unconformably overlying Paleozoic- Cretaceous clastics and carbonates. The upper sequence is conformably passing to the Tertiary fine grained limestones. At the end of Oligocene and begining of Early Miocene, a regional tectonic uplift had occured and then the Miocene formations have continued to deposit on the erosional surface of the older units. In the Tertiary sequence, some unconformities have occurred, related to changes of the extentional tectonics. The oceanic crust of the Red Sea started to form in the Miocene- Pliocene interval.

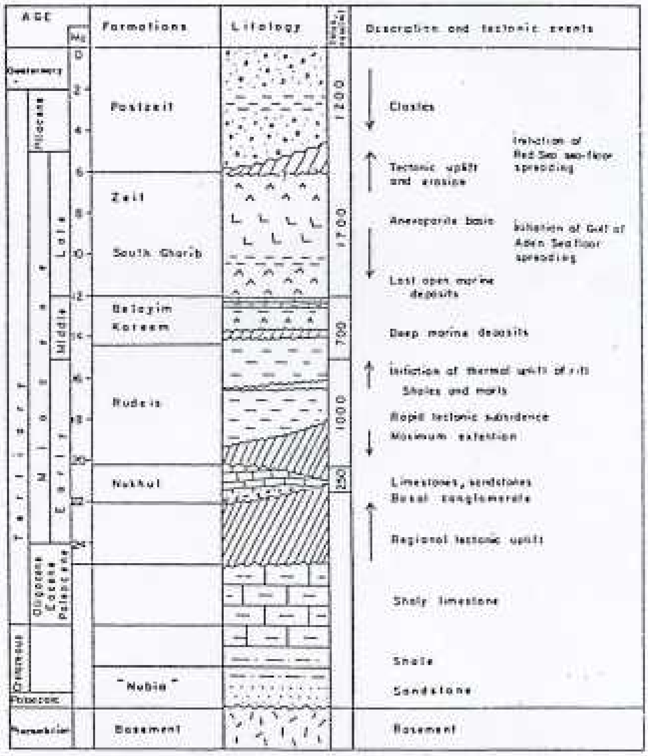


Fig.,4, Generalized geologic column showing stratigraphy and tectonic events of the Northern Red Sea (After Evans, 1988; Miller and Barakat,1988).

Comparing the Upper Maastrichtian-Tertiary stratigraphic columns of the Eastern Taurus Belt (Fig.,3) and the Red Sea region (Fig., 4,), the following results can be obtained:

1-In the Eastern Taurus Belt, the Upper Maastrichtian units overlie unconformably the older tectonic units, but, the terrigenous clastics pass gradually into the fine- grained marine carbonates in the Red Sea area. Thus collision was prevailing in the Eastern Taurus, but extention and subsidance events in the Red Sea area.

2- In the Eastern Taurus, the rate of collision has been accelerated and the basement units, such as the ophiolites, melanges and other units, have been reworked at the end of the Eocene and begining of the Oligocene. This stage represents the paroxysm of the collision. In the Red Sea area this collision caused at first a regional tectonic uplift and then initiated in the opening of it during Late Oligocene and Miocene interval.

3- Local unconformities related to the changes of the collision intensity formed in the Eastern Taurus. The stages of transtention and related intracontinental volcanism, the transpression and related erosional events followed each other respectively. In the Red Sea region the tectonic uplift, erosion and extentional stages followed each other because of the rapid tectonic subsidance. If the compressional events in the north and the extentional events in the south are correlated, it can be seen that these events correspond to each other. In fact, the extention in the south might have been followed by a compression in the north.

4- An important transgressional unconformity is present between the Late Miocene and Pliocene, and it is the record of a transpression event in the Eastern Taurus, in places. During the same interval, the oceanic crust began to develop in the Red Sea area.

Moreover if the displacement rates of the Arabian-African continent relative to the European continent are considered (Livermore and Smith, 1984), the appearing decrease in the rate of convergence in the Late Campanian-Maastrichtian may be a result of the continent-continent convergence and collision. Late Eocene fold axes of the southwestern part of the Sivas basin and of Hınıs basin in the Eastern Taurus are approximately perpendicular to the opening axes of the Red Sea. The collision rate has been accelerated and the Red Sea basin might have begun to develop as an impactogene because of the velocity increase, particularly at Late Eocene. When the opening of the Red Sea and the compressional events in the Eastern Taurus are compared, it can be concluded that the opening of the Red Sea has been controlled by the compressional events prevailed in Eastern Anatolia.

CONCLUSION AND DISCUSSION

In the Eastern Taurus Belt, the collision might have occured in Middle Miocene (Şengör, 1980, Şengör et. al., 1985; Dewey et al.,1986), in Late Eocene-Oligocene (Michard et al, 1985; Akay, 1989; Kazmin, 1989; Aktaş and Robertson, 1990) or at the end of Cretaceous (Adamia et al., 1980; Michard et al., 1985; Yazgan, 1987), especially in Pre-Late Maastrichtian.

If the age of both the ophiolite emplacement and of the post tectonic cover are considered, the Pre-Late Maastrichtian collision can be adopted. The paroxysm of the collision might have been in Late Eocene-Oligocene times and simultaneously rifting may have started between Africa and Arabia, resulting in the initial opening of the Red Sea. As a result, in the light of this discussion and data presented in the paper , the following three points should be emphasized.

1- In the Eastern Taurus Belt the continent- continent collision and related ophiolite obduction have occured in the Pre-Late Maastrichtian.

2- The Upper Maastrichtian-Tertiary Sequence was deposited during the period following the collision in Eastern Anatolia. This sequence shows the environments developed under the control of strike-slip/ oblique-slip faulting.

3- The Red Sea has been developed as an impactogene, due to the paroxysmal compressional events of the collision took place in the Eastern Taurus Belt, during the Oligocene-Miocene.

ACKNOWLEDGEMENTS

This study was made in the extent of MTA geological projects.The authors would like to thank Prof. Dr. Ali Koçyiğit and Dr. İbrahim Çemen for their invaluable suggestions.

REFERENCES

Akay, E. (1989), Evolution of the post- collisional cratonic basins in Eastern Taurus: Mineral Res. Expl.Bull. 109,53-64.

Aktaş,G. and Robertson, A.H.F.(1985). The Maden Complex, SE Turkey: evolution of a Neotethyan active margin: In J.E.Dixon and A.H.F.Robertson (Eds), The Geological Evolution of the Eastern Mediterranean: Geological Society Special Publication, 17, 375- 402.

Aktaş, G. and Robertson, A.H.F.(1990). Controls of sedimentation in a late Cretaceous- Early Tertiary fore-arc setting, S.E.Turkey: International Earth Sciences Congress on Aegean Regions; Abstracts, 1-6 October, 1990, İzmir-Turkey.

Aktimur, T., Atalay, Z., Ateş, Ş., Tekirli, M.E.and Yurdakul, M.E.(1988). Munzur dağları ile Çavuş dağı arasının jeolojisi: MTA Derleme Rap.No. 8320., Ankara.

Bektaş, O. (1981). Kuzey Anadolu Fay Zonunun Erzincan Tanyeri Bucağı yöresindeki jeolojik özellikleri ve yerel ofiyolit sorunları: Ph.D. thesis, KTÜ Yerbilimleri Fakültesi, Trabzon.

Buket, E.(1982). Erzincan-Refahiye ultramafik ve mafik kayaçlarının petrokimyasal karakterleri ve diğer oluşumlarla deneştirilmesi: Yerbilimleri (H.Ü.Yerbilimleri Ens.Bült.),9, 43-56.

Christie-Blick, N. and Biddle, K.T.(1985) Deformation and basin formation along strike-slip faults. In: Biddle , K.T. and Christie-Blick, N. (Eds.), Strike-slip deformation, basin formation and sedimentation: Society of Economic Paleontologists and Mineralogists Special Publications, 37, 1-34.

Çağlayan, A., İnal, N.R., Şengün, M. and Yurtsever, A.(1984).Structural setting of Bitlis Massif. In: Tekeli, O. and Göncüoğlu, M.C. (Eds), Geology of the Taurus belt, Proceedings of International Symposium, 26-29 September 1983, Ankara-Turkey, 245-254.

Dercourt, J.; Zonenshain, L.P.; Ricou, L.E.; Kazmin, V.G.; Le Pichon, X.; Knipper, A.L; Grandjacguet, C.; Sbortshikow I.M.; Geyssant, J.; Lepvrier, C.; Pechersky, D.H.; Boulin, J.; Sibuet, J.C.; Savastin, L.A.; Sarokhtin, O.;Westphal, M.; Bazhenov, M.L.; Laurer, J.F. and Biju-duval, B. (1986). Geological evolution of the tethys belt from the Atlantic to the Pamirs since the Lias; Tectonophysics, 123, 241-315.

Dewey, J.F. ; Hempton, M.R. Kidd, W.S.F ; Şaroğlu, F. and Şengör, A.M.C. (1986). Shortening of continental lithosphere: the neotectonics of Eastern Anatolia - a young collision zone:Geological Society Special Publication, 19, 3-36.

Erdoğan, B. (1977) Geology, geochermistry and genesis of the sulphide deposits of the Ergani Maden Region, SE Turkey : Unpubl. Ph. D. thesis, The University of New Brunswick.

Evans, A.L. (1988). Neogene tectonic and stratigraphic events in the Gulf of Suez rift area, Egypt. In: Pichon X.L. and Cochran J.R. (Eds), The Gulf of Suez and Red Sea Rifting: Tectonophysics, 153, 235 - 247.

Gasanov, T.A. (1986). Evolution of the Sevan - Akera Ophiolite Zone, Lesser Caucasus: Geotectonic, 20/2, 147 - 156.

Gökten, E. and Floyd, P.A. (1987). Geochemistry and tectonic environments of the Şarkışla area volcanic rocks in Central Anatolia, Turkey: Mineralogical Magazine,51, 553 - 559.

Göncüoğlu, M.C. and Turhan, N. (1983). Bitlis Metamorfitlerinde yeni yaş bulguları Mineral Res. Exp. Bull. , 95/96 44 - 48.

International Geological Congress XXIVII Session, Moscow, (1984). Georgian Soviet Socialist Republic, Excursions Guidebook, Publishing house "khelovnebe", 224, Tbilisi.

Kalkancı, Ş. (1974). Etude Geologique et Petrochimique du Sud de la Region de Suşehri, Géochronologie du Massif Syénitique de Köse Dağ. (NE de Sivas Turquie): Thèse de Doctorant de 3[e] cycle, L'Universite de Grenoble.

Kazmin, V. (1989). The Tethys Ocean: Origin of the Terranes: 28th International Geological Congress, Washington, D.C. USA, Abstracts, 2/3, 167 - 168.

Ketin, I. (1966). Tectonic units of Anatolia (Asia Minor) : Mineral Res. Expl. Bull. 66, 23 - 34.

Mc Kenzie, D.P. (1972). Active Tectonics of the Mediterranean Region: Geophys. J. Roy. Astr. Soc. , 30, 109 - 185.

Michard, A; Whitechurh, H; Ricou, L.E. ; Montigny, R. and Yazgan, E. (1985). Tauric subduction (Malatya - Elazığ provinces) and its bearing on tectonics of the Tethyan realm in Turkey. In: Dixon, J.E. and Robertson A.H.E. (Eds), The Geological Evolution of the Eastern Mediterranean : Geological Society Special Publication, 17, 361 - 373, Edinburg.

Miller, P.M. and Barakat, H. (1988). Geology of the Safaga Concession, northern Red Sea, Egypt. In: Pichon, X. Le and Cochron, J.R. (Eds), The Gulf of Suez and Red Sea Rifting : Tectonophysics, 153, 123 - 136.

Özçelik, M. (1985). Malatya güneydoğusundaki Maden magmatik kayaçlarının jeolojisi ve tektonik ortamına jeokimyasal bir yaklaşım: Türkiye Jeol. Kur. Bült. 28/1 19 - 34.

Özgül, N. (1981) Munzur dağlarının jeolojisi: MTA Derleme Rap. No: 6995, Ankara, (unpublished report).

Özgül, N. and Turşucu, A. (1984). Stratigraphy of the Mesozoic carbonate sequencece of the Munzur Mountains (Eastern Taurides). In: Tekeli, O. and Göncüoğlu M.C. (Eds), Geology of the Taurus Belt, Proceedings, 173- 180 Ankara.

Perinçek, D. (1979). Interrelations of the Arabian and Anatolian plates, Guide book for excursion "B", First Geological Congress on Middle East, The Geological Society of Turkey, Ankara.

Perinçek, D. (1980) Arabistan kıtası kuzeyindeki tektonik evrimin, kıta üzerine çökelen istifteki etkileri: Türkiye 5. Petrol Kongresi, Proceedings, 77 - 93, Ankara.

Reading, H.G. (1980). Characteristics and recognition of strike -slip fault systems. In: Ballance P.F. and Reading H.G. (Eds), Sedimentations in oblique-slip mobile zones, Special Publication Int.Ass. Sediment. , 4, 7-26.

Şengör, A.M.C. (1979). Mid.- Mesozoic closure of Permo - Triassic Tethys and its implications: Nature, 279, 590 - 593.

Şengör, A.M.C. (1980). Türkiye'nin neotektonik esasları : Türkiye Jeol. Kur. , Special Publication, 2, 40, Ankara.

Şengör, A.M.C. (1984). The Cimmeride Orogenic System and the Tectonics of Eurasia: Geological Society of America, Special Paper 195, 74.

Şengör, A.M.C. and Yılmaz, Y. (1981) Tethyan evolution of Turkey: A plate tectonic approach: Tectonophhysics, 75, 181 - 241.

Şengör, A.M.C. ; Görür, N. and Şaroğlu, F. (1985). Strike - slip faulting and related basin formation in zones of tectonic escape : Turkey as a case study: The Society of Economic Paleontologists and Mineralogists, Special Publication, 37, 227 - 264.

Terlemez, I. and Yılmaz, A. (1980). Ünye - Ordu - Koyulhisar - Reşadiye arasında kalan yörenin stratigrafisi : Türkiye Jeol. Kur. Bült, 23/2, 79 - 191.

Terzioğlu, M.N (1984). Ordu güneyindeki Eosen yaşlı Bayırköy volkanitlerinin jeokimyası ve petrolojisi: Cumhuriyet Üniversitesi Mühendislik Fakültesi Dergisi, 1/1, 43-60.

Terzioğlu,M.N. (1985 a). Reşadiye (Tokat) kuzeyindeki Eosen yaşlı Hasanşeyh platobazaltının mineralojik, petrografik ve jeokimyasal incelemesi: Cumhuriyet Üniversitesi Mühendislik Fakültesi Dergisi, Seri A- Yerbilimleri, 2/1, 105-134.

Terzioğlu, M.N. (1985 b). Reşadiye (Tokat Kuzeybatısındaki Hasandede Andeziti'nin mineralojik-petrografik ve jeokimyasal incelemesi: Cumhuriyet Üniversitesi Mühendislik Fakültesi Dergisi, seri.A- Yerbilimleri, 2/1, 135-149.

Terzioğlu,M.N. (1986 a). Doğu Karadeniz bölgesinde Pliyosen yaşlı Erdembaba volkanitlerinin petrolojisi ve kökensel yorumu: Türkiye Jeol.Kur.Bült., 29/1, 119- 132.

Terzioğlu, M.N.(1986 b), Reşadiye, Gölköy ve Koyulhisar arasındaki Tersiyer Kuvaterner yaşlı volkanitlerin genel stratigrafik özellikleri: Cumhuriyet Üniversitesi Mühendislik Fakültesi Dergisi, seri. A-Yerbilimleri; 3/1 3-13.

Terzioğlu, M.N. (1987). Orta Karadeniz bölgesindeki Pliyosen yaşlı Canik volkanitlerinin mineralojik-petrografik ve jeokimyasal incelemesi: Türkiye Jeol. Kur. Bült., 30/1 71-85.

Yazgan, E.(1983).A Geotraverse between the Arabian Platform and the Munzur Nappes: International Symposium on the Geology of the Taurus belt, Guide Book for Excursion V.,Ankara.

Yazgan, E.(1984). Geodynamic evolution of the Eastern Taurus region. In: Tekeli, O. and Göncüoğlu, M.C. (Eds), Geology of the Taurus Belt, Proceedings, 199-208, Ankara.

Yazgan,E. (1987) Malatya güneydoğusunun jeolojisi ve Doğu Toroslar'ın jeodinamik evrimi: MTA Derleme Rapor no: 8272, Ankara.

Yılmaz, A. (1980). Tokat ile Sivas arasındaki bölgede ofiyolitlerin kökeni, iç yapısı ve diğer birimlerde ilişkisi: Ph. D. thesis, Ankara Universitesi Fen Fakültesi Jeoloji Kürsüsü, Ankara.

Yılmaz, A. (1981). Tokat ile Sivas arasındaki bölgede bazı volkanitlerin petrokimyasal özellikleri: Türkiye Jeol. Kur. Bült. , v. 24/2,p.51 - 58.

Yılmaz, A. (1982,) Dumanlı dağı (Tokat) ile Çeltek Dağı (Sivas) dolaylarının temel jeoloji özellikleri ve ofiyolitli karışığın konumu: MTA Derleme Rap. no: 7230, Ankara.

Yılmaz, A. 1989, Kafkasya'nın tektonik kuşakları ve bu kuşakların kuzeydoğu Türkiye'deki uzantıları: Bir karşılaşurma: MTA Dergisi 109, 89 - 106.

Yılmaz, A. , Terlemez, I. and Uysal, Ş. (1988). Some stratigraphic and tectonic characteristics of the area around Hınıs (Southeast of Erzurum): Mineral Res. Expl. Bull. , 108, 1 - 21.

Yılmaz, A., Terlemez, I. and Uysal, Ş. (1990) Geological characteristics and structual evolution of the ophiolitic units around Sakaltutan Dağı (Erzurum): METU Journal of Pure and Applied Sciences, 21, 1 - 3. 221 - 235.

Yılmaz, Y. (1980) Atlantik tip bir kıta kenarının Pasifik tip kıta kenarına dönüşümüne Türkiye'den örnek: Türkiye Jeol. Kur. Special Publication no:1, Ankara.

Zakariadze, G.S. ; Knipper, A.I. ; Sobolev, A.V. ; Tsamerian, O.P. ; Dimitriev, L.V. ; Vishnevskaya, V.S. ; Kolasov, G.M., (1983), The ophiolite volcanic series of the Lesser Caucasus: Ofioliti, 8 (3) 439 - 466.

DISCUSSION

Ünlügenç, U. C.: Could you give me the age of the first thrust along the Bitlis Suture ?

Reply : The age of the first thrust is not known along the Bitlis imbricate zone. In addition, it is difficult to decide if there is a Bitlis suture or not, but there may have been some overthrusts active since the end of Eocene.

Sengün, M. : Do you think that Cretaceous collision is consistent with the sedimentary history of Maden Basin ?

Reply : The Maden unit, representing volcano-clastic rocks, overlies the Bitlis-Puturge metamorphics unconformably. This unit may have been formed after collision in the transitional stage. Sedimentary characteristics of this unit are appropriate to this stage.

Cemen I. : How is it possible that the Red Sea is opened as an impactogen ?

Reply : Fold axes of Eocene, representing paroxysm of collision, are approximately perpendicular to the opening axes of the Red Sea, so the Red Sea started to open after collision as an impactogen, during Oligocene-Miocene transition.