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UPPER CRETACEOUS/PALEOCENE TRANSITION RELATIONS IN THE GÜRÜN AUTOCHTHON, EAST TAURIDES-SW SİVAS (TURKEY)

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ABSTRACT.- The aim of this study is to determine the upper Cretaceous/Paleocene relation in the Akdere Basin (Gürün-SW Sivas) of eastern Taurids. The upper Cretaceous/Paleocene boundary in the studied is well observed. Microbreccia levels with intraformational conglomerate/breccia and biogenic limestone occurrences exist in places along the upper Cretaceous/Paleocene boundary. The rocks in the microbrecciated character show a texture of biolithclast packstone-grainstone and their depositional environment grades from slope to the basin. Most of the intraformational conglomerate/breccias on the upper Cretaceous/Paleocene boundary indicate possible movements of the sea floor controlled by tectonism during this time. On the uplifted blocks of the faults, syngenetic with the sedimentation, an environment which is vulnerable for some reef-building organisms, such as algae-corals and Bryozoa, was developed and biogenic limestones were deposited. Intraformational conglomerate/breccias were accumulated as resedimented rocks on the slopes and steeps of the fault fronts. As a result of these activities, sedimentary fissures (Neptunian dykes) were formed due to the crackings on the sea floor. This basin movement on the upper Cretaceous/Paleocene boundary gave also rise to the development of local uncorformities (hiatus).

INTRODUCTION

Based on the fossil data, a number of 15 extinction events has been determined through the geological times. Of these, the ones is upper Permian and upper Cretaceous were used to determine the boundaries between Paleozoic, Mesozoic, and Cenozoic systems. Although the biologic crisis on the Permo-Triassic boundary can be easily explained by the plate tectonics, the biologic crisis on the upper Cretaceous/Paleocene boundary with the sediment variations observed on the C/T boundary are attributed to different matters. Alvarez et al. (1980) and Officer and Drake (1983; 1985) explained the biologic crisis and the variations in sediments with a impact of meteorite and volcanism hypotheses, respectively.

Erosion caused by the submarine cold water currents, hiatus observed on the boundary in most places, widespread clay occurrences, increase in the carbonate dissolution, and the fluctuations in the sea level associated with tectonism are some of changes observed in the sediments on the Upper Cretaceous/Paleocene boundary. The reasons of the changes were studied by various workers. Moore et al. (1978), Keller and Barron (1983) and Keller et al. (1987) tested the presence of deep sea hiatus in Paleogene and described them as mechanical and chemical erosion surfaces on which no sedimentation takes place. According to these workers, condensation of oxygene-18, an increase or decrease in the number of planktonic foraminifer species, dissolution of carbonates, and a drop in the sea level are the main factors affecting the sedimentation. Accordi and Carbone (1992) and Lucic et al. (1993) determined the hiatus in Adriatic and attributed them to the planktonic foraminifers, nannoplanktones, and lithostratigraphy. The presence of clays was observed in various C/T boundaries by Officer and Drake (1985), in Spain, Denmark, and New Zealand by Schmitz (1988), and in Montana C/T boundary by Fastovsky et al. (1989). The biologic crisis on the C/T boundary and the change in the sediment character are attributed to a drop in the sea level by Ekdale and Bromley (1984), an increase in temperature by Emiliani (1980), and calcite dissolution due to surficial water by Officer and Drake (1983). Raup and Sepkoski (1984) stated that the biologic crisis is periodical and that it is repeated in every 26 million years. Hsu et al. (1982), however, point out that catastrophic environmental change in the beginning of Paleocene gave rise to the biologic crisis and affected the accumulation of sediments. Arthur et al. (1977) examined the upper Cretaceous/Paleocene sequence in Gabbio, Italy, in lithostratigraphic-sedimentologic-magnetostratigraphic and biostratigraphic ways. Butler et al. (1977) studied the *C/T* boundary of San Juan Basin, New Mexico, in a magnetostratigraphic way. Surlyk (1980) discussed the evolution of C/T boundary.

The main objective of this study is to determine whether microbreccia levels with intraformational conglomerate/breccia and biogenic limestone occurrences observed on the *C/T* boundary of the study area were formed as a result of one or more causes representing the changes in the sediment character that are stated above. It will be also explained that there is break in sedimentation and if there is any, this is whether due to a submarine erosion, carbonate dissolution, cooling of the sea water, or tectonics.

In some studies carried out in Turkey, upper Cretaceous/Paleocene relation is based on biostratigraphic and mineralogic data (Ünalan et al., 1976; Sirel et al., 1986; Yalçın and İnan, 1992).

Considering the objective of this study, columnar sections of lateral direction in close distances were measured in Akdere village, 30 km West of Gürün (Figure 1A), to the north Kahvepınarı place, north of Abdalpınarı village, and between Ziyaret Hill and Arpaçukuru village (Fig. 1B). Sedimentary petrography, electron (SEM), and paleontological studies were conducted on the samples collected. The possible events on the upper Cretaceous/Paleocene boundary are explained by combining the results obtained from these studies with the field observations.

THE LITHOFACIES DESCRIPTION OF THE UPPER CRETACEOUS/PALEOCENE BOUNDARY

The upper Cretaceous/Paleocene boundary in the study area is located south of the Akdere foreland-intermountain basin which was developed on the Gürün autochthon (Atabey, 1993b) (Fig. 1B). It is traced about 20 km in between the Kahvepınarı place and the Arpaçukuru village (Fig. 1B) Lithostratigraphic criteria descriptive for the *C/T* boundary in this place are brecciation, changes in the thickness of bed, lateral unconformities, and lateral facies changes. A number of four facies types was differentiated on the *C/T* boundary with the aid of field and laboratory data obtained from the columnar sections taken in close distances along the boundary. These are; conglomerate/breccia facies (Facies-1), reef-biogenic limestone facies (Facies-2), bio-intra-lithoclast packstone-grainstone facies (Facies-3), and pelagic mudstone-wackestone facies (Facies-4). These facies are not characterized with together but locally with only a few them.

Facies-1: Conglomerate/breccia facies

It is seen in dark gray, yellowish, and brown colors in the field. It is exposed in the Ziyaret hill 500 m north of Abdalpınarı. The facies with massive and thick bedded character has a thickness of 7 m in the Ziyaret hill. The unit, cropping out on the upper Cretaceous pelagics again. The steepness of a fault trending along the E-W direction on the Ziyaret hill forms a topographic mound (Fig. 2). Conglomerate/breccia facies sets above the pelagic mudstone-wackestone (Akdere. Fm.) of upper Cretaceous age (upper Campanian-Maestrichtian) at the basement. It is overlian by the reef-biogenic limestone.

This facies with a intraformational conglomerate/breccia character is composed of angular, subangular, and subrounded pebbles with a grain size of 5-30 cm. 85 % of the pebbles carbonates (Yanıktepe Fm.) comprising the basement. Grains are tightly bounded by a carbonate cement. This facies type is only seen at the Ziyaret hill along C/T boundary (Fig. 1B, section no 2).

Facies-2: Reef-biogenic limestone facies

Like the Facies-1, this facies type is also located at the Ziyaret hill. It is distinguished from the conglomerate facies with its light gray, whitish color (Figure 3). Its typical exposure is at the Ziyaret hill. It is completely massive and displays a thickness between 1 and 5 m. The unit, laterally cropping out along a distance of 0.5-1 km, is pinched out by the pelagic rocks. The facies is laterally transitional with the informational conglomerate/breccias at the basement and is covered by the pelagics above.

It shows a boundstone texture under microscope. Most of its constituents are red algae *(Lithot-*

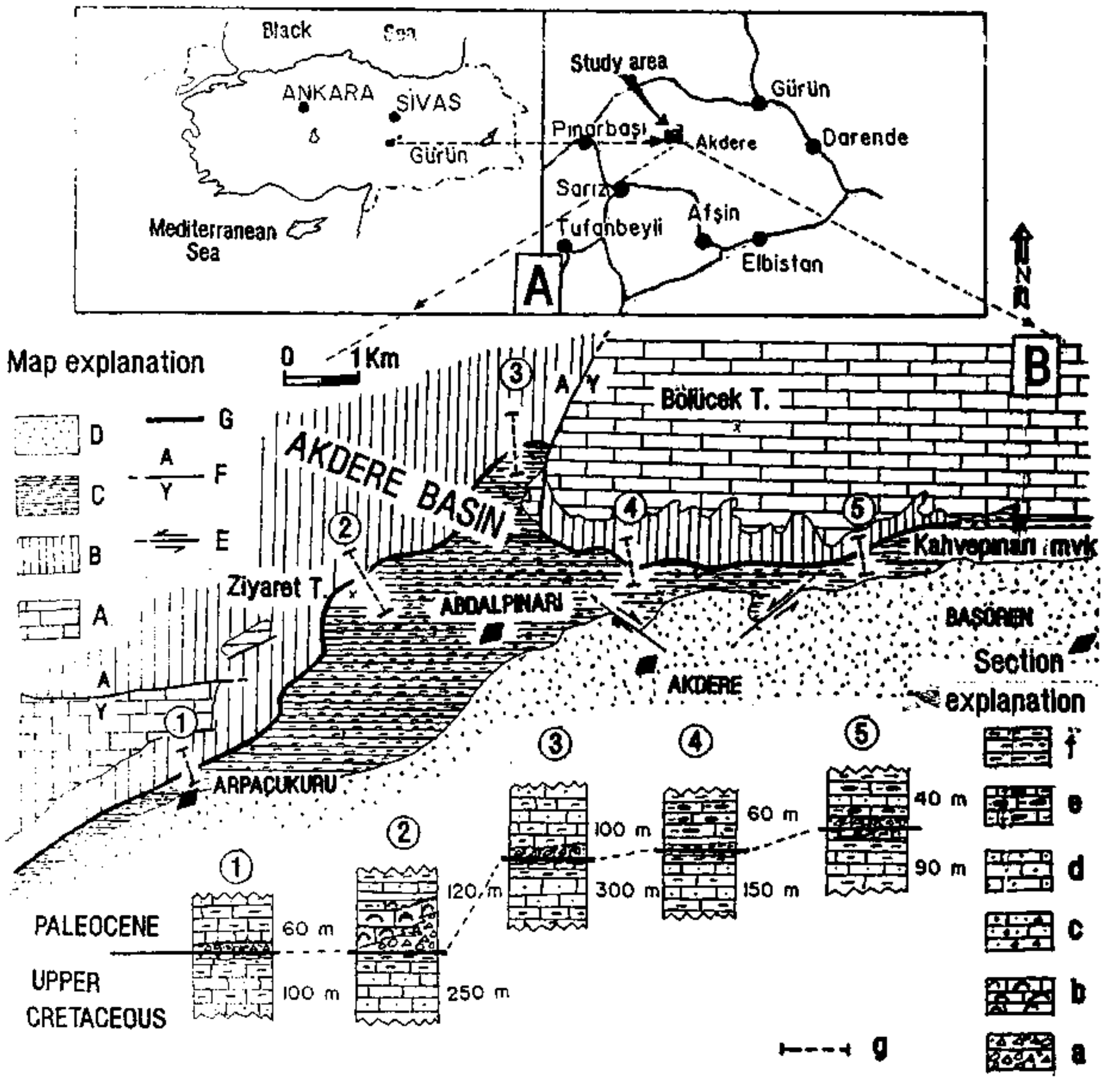

Figure 1. (A)-Location map, (B)-Geological map upper Cretaceous/Paleocene boundary: Map Explanations: A-Upper Santonian-Campanian (Yanıktepe Fm.), B-Upper Campanian-Maestrichtian (Akdere Fm.), C-Paleocene (Abdalpınar Fm.), D-Lutetian unit, E-Strike slip fault, F-slip fault, G-C/T boundary, Section Explanations: a-Conglomerate/breccia, b-Algae limestone, c-Breccia/calcarenite, d-Calcarenite, e-Nodular chert bearing clayey limestone, f-Marl, g-Section locations.

hamnium sp., *Archeaolithothamnium* sp., *Mesophyllum* sp., *Coralline* sp., *Lithophyllum* sp.), *coral, Broyozoa* sp., Miliolidae, echinoid, and some benthic foraminiferas. Fragments of pelagic mudstone-wackestone (belonging to upper Cretaceous) and mud pellets with intraclasts are also contained in the rock. The pores of Broyozoa and the braches of the corals are filled with a calcite cement giving a roofstone texture (Embry and Klovan, 1971) to the rock.

Facies-3: Bio-intra-lithoclast packstone-grainstone facies

It is shown along the C/T boundary in the sections no 1, 3, and 5 (Fig. 1). The facies shows a microbrecciform character as an interlayer between the pelagic rocks (Fig. 4). The bed thickness is between 20-30 cm in section no 1, 10-20 cm in section no 3, and 20-30 cm in section no 5.In all these three locations, the facies laterally continues along a length of 200-300 m.

These microbreccias display a bio-intra-lithoclast packstone-grainstone texture under microscope (Dunham, 1962). Some lithoclasts belong to the shallow water carbonates (Yanıktepe Fm.: upper Santonian-Campanian) and some belong to the pelagic mudstone-wackestones (Akdere Fm.: upper Campanian-Maestrichtian). Intraclasts, however, belong to rock units of Paleocene age (Abdalpınarı Fm.) (Atabey, 1993a). Fissure-fracture and scour structures are developed in the rock. The boundaries of fissure and fractures have the traces of in-situ breaking (Fig. 5 and 6). Fissure and fractures are filled with shallow marine benthcis, algae, miliolids, echinoids, and lime mud (Fig. 5, 6 and 8). The structures formed by these type fractures and filling of them with the sediments is known as Neptunian dykes which indicate a submarine erosion (Pavlow, 1896, Bates and Jackson, 1980). Syntaxial cement developed in the echinoids within the fractures indicates a pheratic marine conditions. It also points out that the character of the environment was changed from deep to shallow marine condition (Fig. 7). The presence of dissolution pores or scours in calcites was also observed in the electron microscope photographs (Fig. 9). This dissolution process is accomplished by cold water currents. Mud lithoclasts forming the rock comprise foraminifera and nannoplanktons of upper Campanian-Maestrichtian age while syngenetic intraclasts comprise foraminiferas of Paleocene age and abundant amounts of nannoplanktons (Atabey, 1995). The names of the fossils are given in Facies-4.

Facies-4: Pelagic mudstone-wackestone facies

This facies takes place as an interlevel below both conglomerate/breccia facies and microbreccias and also above the microbreccias. The ones below the Facies-1 and Facies-3 are the pelagic levels belonging to upper Cretaceous while the ones above these facies are the pelagic levels belonging to Paleocene. These rocks presents in both levels completely show a pelagic mudstone-wackestone texture. These thin bedded pelagics can be laterally traced. Most of the constituents of lime muds belonging to both upper Cretaceous and Paleocene are composed of foraminifers and nannoplanktons. The foraminiferas of upper Campanian-Maestrichtian are: *Globotruncana linneiana, Globotruncana cf. area, Globotruncana subspinosa, Globotruncana falsostuarti, Globotruncana stuarti, Globotruncana conica.* The nannoplanktons are: *Predicosphaera cretacea, Eiffellithus turriserffelli, Quadrum trifidum, Calcuqutes obscurus, Arkhangelskella cymbiormis, Microrhabdulus decoratus.* The foraminifers of Paleocene are: *Morozovella cf. pseudobulloides, Planorotalites cf. compressa, Globoratalia cf. velascoensis, Globoratalia stuarti, Opertorbitolites sp. The nannoplanktons are: Discoaster multiradiatus, Ericsonia cava, Ericsonia ovalis, Cocolithus eopelaqcus, Ellipsolithus macellus, Sphenolithus primus.*

DISCUSSION

The upper Cretaceous/Paleocene boundary in the study area is partly differentiated with the pelagic limestones of brecciform character. In addition, the local reef developments and biogenic, clastic limestone levels are the other facies assemblages of this boundary. The lateral and vertical relations on the C/T boundary, which reflects a shallow marine depositional environment, are the product of syngenetic faulting previaled in the basin at that time. Another feature supporting for the movement of the sea floor is the development of sedimentary fractures (Neptunian dykes). The filling of these fractures, wholly observed in the pelagic levels, with the shallow marine bioclastics is an indicative of the current movements effective on the sea floor. Syngenetic faultings were dominant during the C/T stage and, hence, some rising sites were locally developed. The typical example of this at the Ziyaret hill. Intraformational conglomerate/breccias (Facies-1). Were accumulated as resedimented rocks on the slopes and steeps of the faults syngenetic with the sedimentation. A shallow marine environment was prevailed on the uplifted blocks of the faults and conditions vulnerable for the deposition of algae-coral-bryozoa bearing reef limestones were developed at these sites (Facies-2). Along all the C/T boundary, in places, where the syngenetic faultings were not effective or the strike was not large, deep marine conditions were prevailed. Consequently, while local shallow environments were developing along the boundary (as in the case of Ziyaret hill), basin-slope environment conditions were also dominated in places (section locations no 1, 3, 4, and 5). Continuous faulting of the basin slope affected the sediment character. The movement on the sea floor gave rise to fracturings in the basement sediments and these fractures were filled with the pelagic muds, pelagic foraminifers, and some organisms dragged from the platform margin with submarine current. Neptunian dykes were formed in this way and the rock had a microbrecciform character (Facies-3). Lehner (1991) stated that Neptunian dykes could be formed as a result of the movement of syngenetic faults developing along the platform margin-basin slope. In the electron microscopy studies conducted on the microbreccias, dissolutions on the fossil shells, sweeping out of carbonates by the current motion, and some breaks in the sedimentation were observed. The dissolution of carbonates on the C/T boundary negatively affected the carbonate accumulation and, therefore, local hiatus were developed. Syntaxial cement development detected in the echinoids indicates that the deepening in the environment was not continuous. This type of cement also indicates that in some cases, the environment was getting shallower and was subjected to the fresh water occupation.

The breaks in the sedimentation together with the sea floor movements on the C/T boundary and sea floor erosions are the indicative of the presence of submarine unconformaties (hiatus).

It is concluded that at that time, there were rises and drops in the sea level on the C/T boundary, dissolution of carbonates depending on the depth thus affecting the accumulation of sediments, development of shallow marine facies depending on the sea level rising, development on neptunian dykes due on the sediments of the sea floor caused by syngenetic faults, and this activity also gave rise to some local unconformities (hiatus).

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PLATE

PLATE -I

Fig. 2. Conglomerate/breccia level (Facies-1) at the basement of Paleocene, 1 km north of the Abdalpınarı village, Ziyaret hill.

Fig. 3. Biogenic limestone facies (Facies-2). Algae-Coralla-Broyozoa bearing reef limestone occurrences. 1 km north of the Abdalpınarı village, Ziyaret hill.

Fig. 4. Microbreccia levels observed on the upper Cretaceos/Paleocene boundary, 1 km north of the Akdere village, site of Section no 5.

Fig. 5. Fissures developed in the pelagic mudstones indicate the fracturing of the sea floor. These are filled with the carbonate grains derived from them. A calcite cement develops in other spaces (white areas). Pelecypod (P), Red algae (A), Mud clast (K), x63.

Fig.6. Sedimentary fractures developed within the pelagic mudstone-wackestone. Red algae filling the fractures (A), Lime mud clasts (K), and lime mud (Kg), x63.

Fig. 7. Syntaxial cement detected in echinoids (S), echinoid (E) characterize the pheratic marine environment. The sample examined belongs to the microbreccia levels (Facies-3), x63.

Fig. 8. Biogenic scours developed in the pelagic mudstones. Scour pores are filled with the lithoclast (L), milliolid (M), and algae (A). White part stand for calcite cemented areas, x63.

Fig. 9. SEM image of dissolution pores (B) observed in the biogenic grains within the lime mud (x2000).

Fig.2

Fig.3

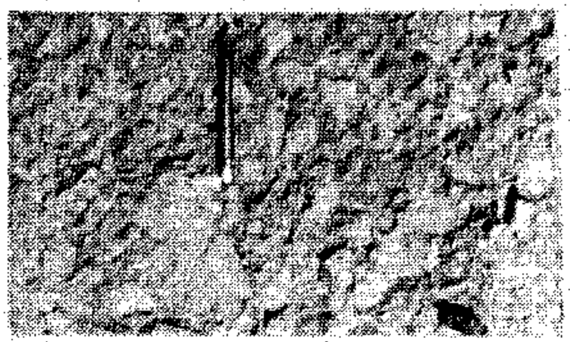

Fig.4

Fig.5

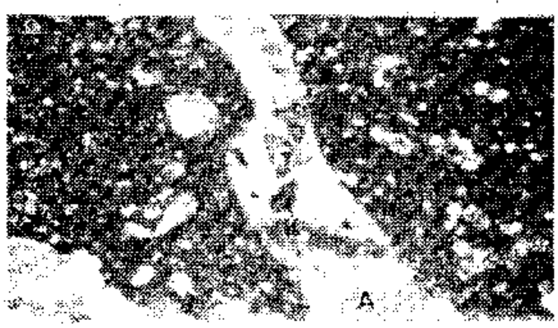

Fig.6

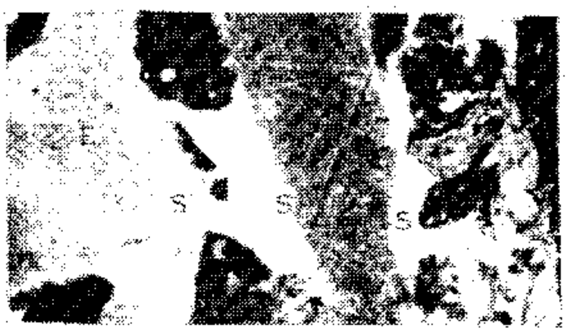

Fig.7

Fig.8

Fig.9