Cretaceous Carbonate Platforms

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Chapter 14

Rudist Carbonate Ramp in Southeastern Anatolia, Turkey

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SUMMARY

Name: Arabian platform
Author: S. Özer
Location: From 36° to 38° 15′ north latitude and 36° to 39° 30′ east longitude, southeastern Anatolia
Geologic time interval: Late Cretaceous, Maastrichtian
Tectonic–sedimentary setting: Intracratonic basin
Basin type: Epeiric shelf
Paleoclimate: Semi-tropical
Platform type: Ramp
Platform geometry: 320 m thick, approximately 35 km wide, and 300 km long
Facies and fossils: Carbonates, conglomerates, sandstones, and shales; rudists, corals, algae, molluscs, benthonic and planktonic foraminifera
Systems tracts: Beach, shallow shelf, basin
Stacking patterns: Not determined

INTRODUCTION

Southeastern Anatolia is located on the northern side of the Arabian plate. In this region, Maastrichtian rudist limestone outcrops are observed mainly along the border folds belt, which lies geologically between the Taurus orogenic belt to the north and the foreland area to the south (Figure 1). Because of the oil potential in this area, the geology of southeastern Anatolia has been studied in detail by the Turkish Oil Company (T.P.A.O.). Righo de Righi and Cortesini (1964), Sungurlu (1974), Yalçìn (1976), and Perinçek (1979, 1990) are significant references for the geologic evolution of southeastern Anatolia. The paleontology of the benthonic–planktonic foraminifera and rudists has been studied by Meriç (1965, 1987) and Özer (1986, 1988a,b, 1991). The sedimentologic characteristics of the Maastrichtian units have been presented by Perinçek (1979), Meriç et al. (1985, 1986), and Özer (1992).

REGIONAL GEOLOGIC SETTING

The Campanian–early Maastrichtian was a period of important tectonic movement in southeastern Anatolia. During this period in the northern part of the Arabian platform, the Kastel intracratonic basin was formed. The Kastel Formation, which consists of alternating shale and sandstone with planktonic foraminifera, was deposited in this basin (Figure 2). During the deposition

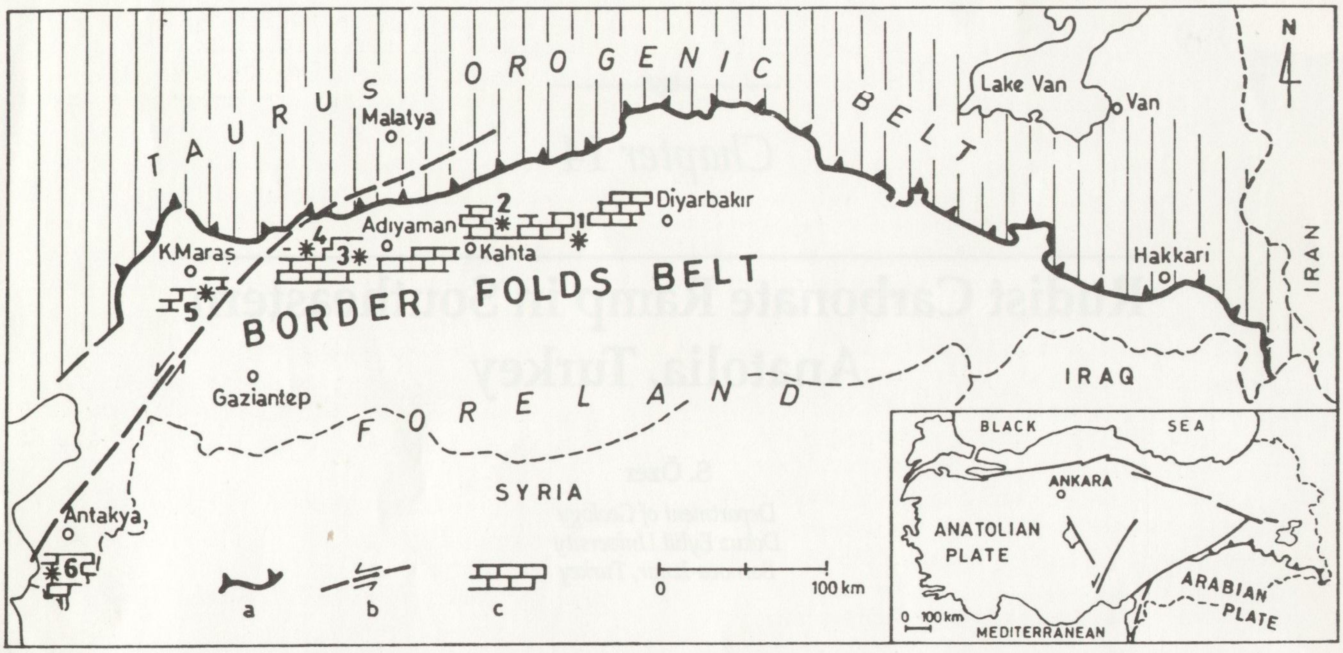

Figure 1. Structural sketch map showing the distribution of rudist outcrops in southeastern Anatolia. Key: (a) Elazig–Bitlis overthrust; (b) East Anatolian fault belt; (c) rudist outcrops; asterisks (*) indicate locations of measured stratigraphic sections (1–6) in Figure 4.

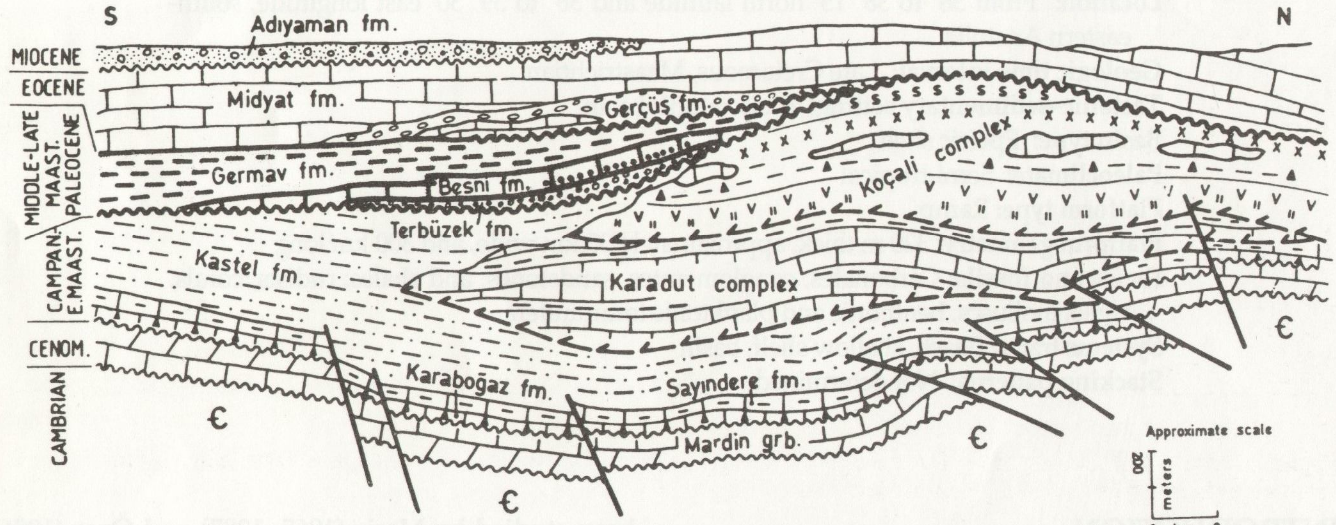

Figure 2. Generalized geographic cross section of southeastern Anatolia showing the stratigraphic position of the transgressive sequence containing rudist limestones and comprising the Terbüzek, Besni, and Germav formations. (Modified from Sungurlu, 1974, and Perçinek, 1979.)

of the Kastel formation, two successive allochthonous units belonging to the Taurus belt (the Karadut Complex overlain by the Koçali complex) were transported into the basin by gravity slides. This caused a shift in the axis of the depocenter to the south (Figure 2). The Karadut Complex is Cenomanian–early Turonian in age based on its fossil content (Sungurlu, 1974), and it consists of shale, thick-bedded limestone, clayey limestone, pebbly limestone, interbedded chert, and turbiditic conglomerate. The Koçali Complex is composed of the following (from bottom to top): volcanics (submarine lava, spilitic basalt, and diabase), sedimentary rocks (limestone with pelagic foraminifera, dolomitic limestone, shale, radiolarian chert, and block limestone), and serpentinites. It is Late Jurassic–Early Cretaceous in age (Sungurlu, 1974).

As tectonic activity declined at the end of the early Maastrichtian, a transgression of the Arabian platform began from south to north. The transgressive sequence consists of three units, in ascending order: the

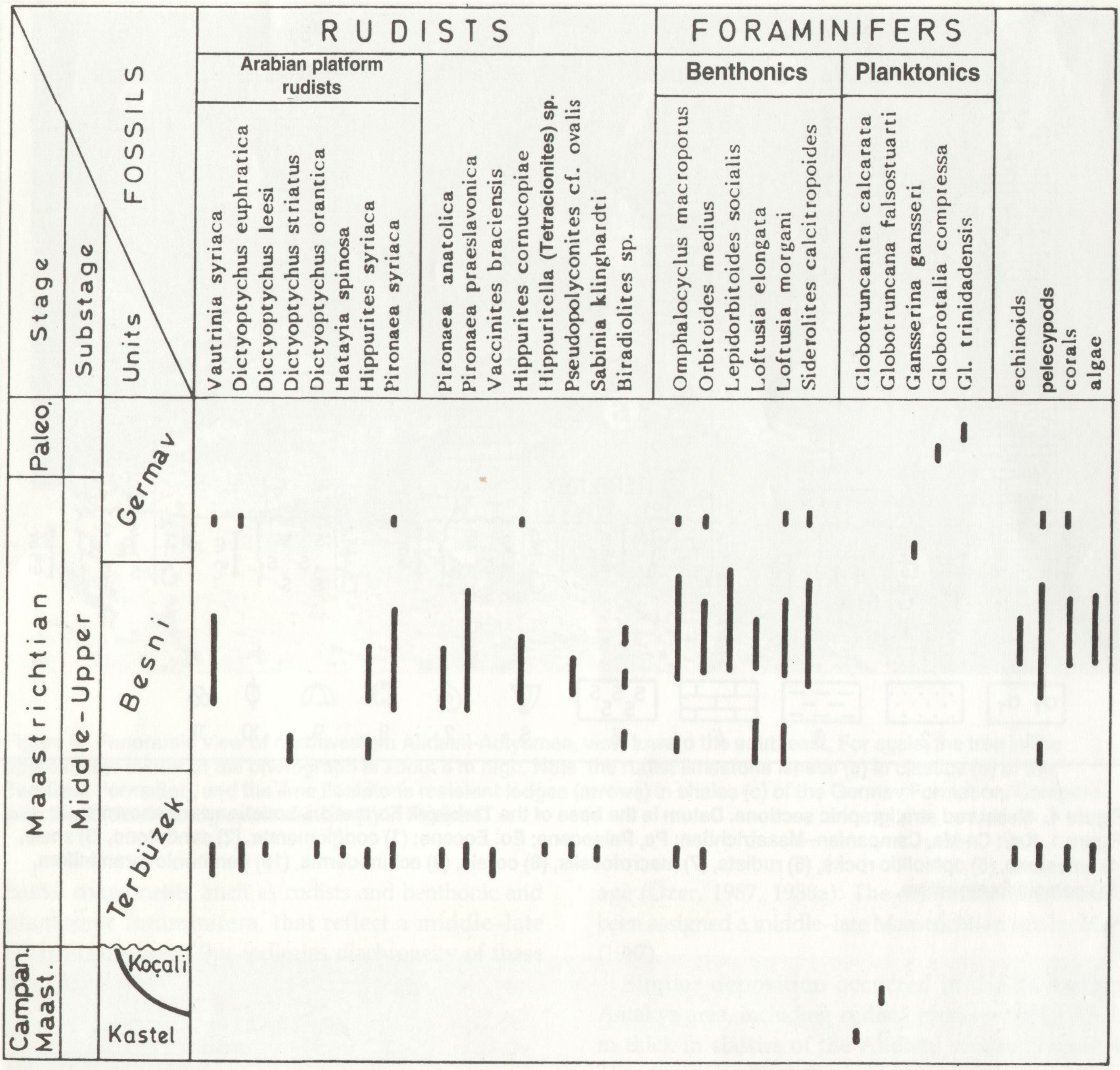

Figure 3. Stratigraphic chart of the Maastrichtian transgressive units showing occurrences of selected rudists, foraminifera, and other fossils. (Foraminifera from Meriç, 1987.)

Terbüzek, Besni, and Germav formations (Figures 2 and 3). Each of these formations contains rudists. They crop out mainly between the Kahraman Maras and Diyarbakìr regions (Figure 1). Maastrichtian rocks with rudists also crop out around Yaladagì–Antakya.

The transgressive Maastrichtian sequence of southeastern Anatolia was deposited on an epeiric shelf situated on the northern border of the Arabian plate. This shelf was located about 22° north paleolatitude, according to the Cretaceous map prepared by Decourt et al. (1985). The geometry of the transgressive facies is best exhibited around the areas of Terbüzek, Besni, and Kahta (Figure 1).

DEPOSITIONAL SETTING AND LITHOFACIES DESCRIPTIONS

The Maastrichtian transgressive sequence unconformably overlies the Koçali Complex. Elsewhere, it unconformably overlies the autochthonous Kastel Formation (Figures 2, 3, 4, and 5). This sequence is overlain by clastics of the Gerçüs Formation and the carbonate Midyat Formation of Eocene age (Figure 2). The Terbüzek and Besni formations and the lower part of the Germav Formation show lateral and vertical changes from one to another and are composed of

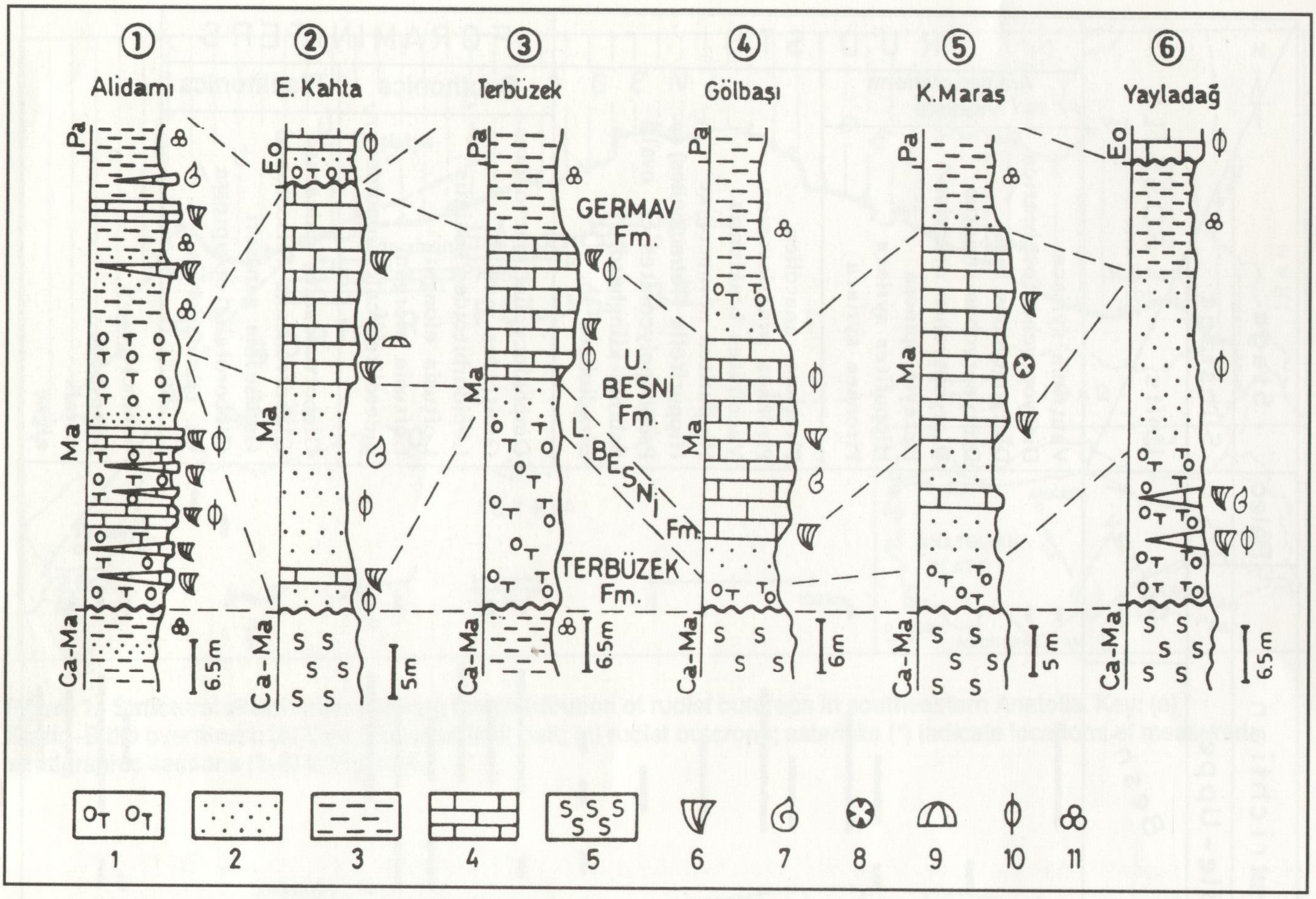

Figure 4. Measured stratigraphic sections. Datum is the base of the Terbüzek Formation. Locations are shown in Figure 1. Key: Ca-Ma, Campanian–Maastrichtian; Pa, Paleocene; Eo, Eocene; (1) conglomerate, (2) sandstone, (3) shale, (4) limestone, (5) ophiolitic rocks, (6) rudists, (7) macrofossils, (8) corals, (9) echinoderms, (10) benthonic foraminifera, (11) pelagic foraminifera.

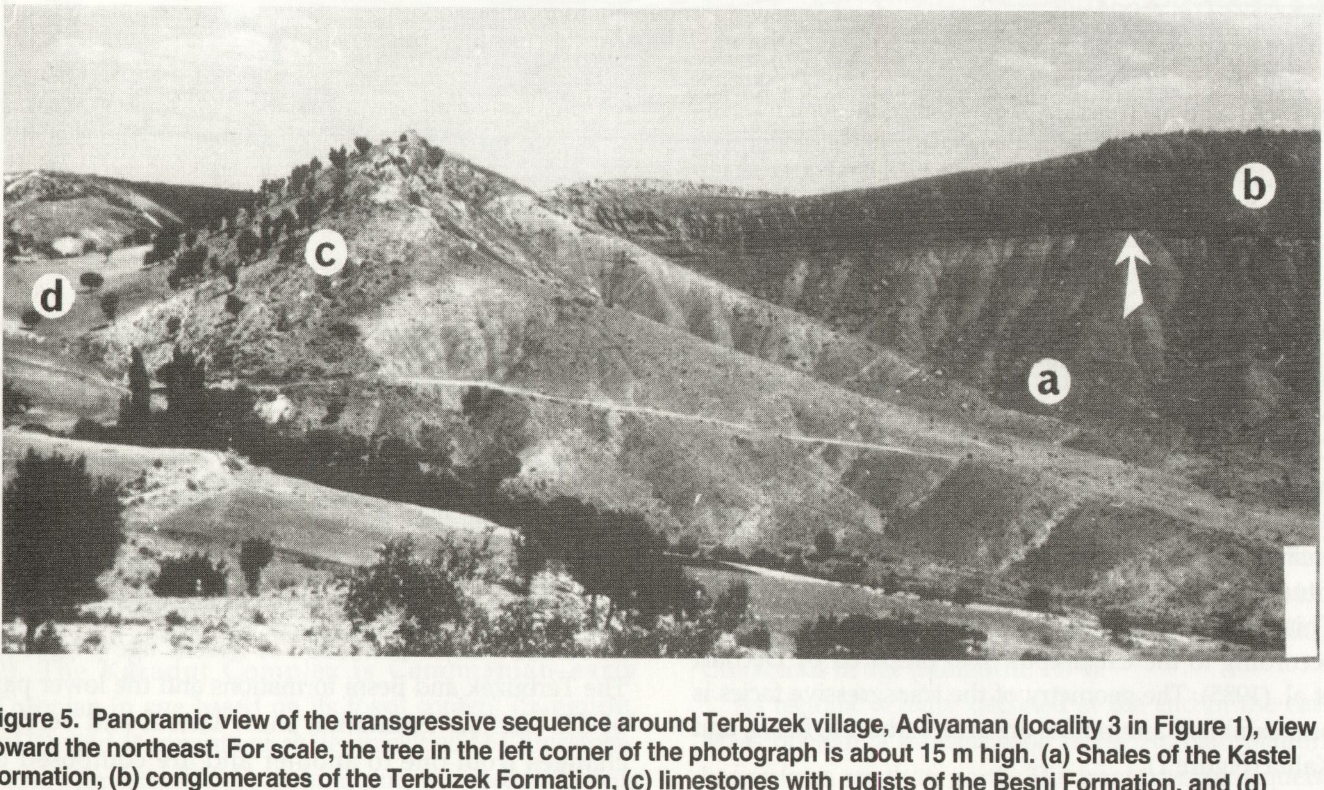

Figure 5. Panoramic view of the transgressive sequence around Terbüzek village, Adiyaman (locality 3 in Figure 1), view toward the northeast. For scale, the tree in the left corner of the photograph is about 15 m high. (a) Shales of the Kastel Formation, (b) conglomerates of the Terbüzek Formation, (c) limestones with rudists of the Besni Formation, and (d) shales of the Germav Formation. Note the angular unconformity (arrow) between the transgressive sequence and the Kastel Formation.

Figure 6. Panoramic view of northwestern Alidamì-Adìyaman, view toward the southeast. For scale, the tree in the approximate center of the photograph is about 4 m high. Note the rudist limestone lenses (a) in clastics (b) of the Terbüzek Formation, and the lime floatstone resistant ledges (arrows) in shales (c) of the Germav Formation. Compare with the Alidamì stratigraphic section (1) in Figure 4.

faunal components, such as rudists and benthonic and planktonic foraminifera, that reflect a middle–late Maastrichtian age. This indicates diachroneity of these formations.

Terbüzek Formation

The Terbüzek Formation, which ranges from 5 to 90 m in thickness, is composed of red and green poorly sorted, thick- to very thick-bedded comglomerate and sandstone. It also contains red and green shale. The pebbles of the conglomerates were derived from the Koçali Complex. Fossils are sparse in the Terbüzek Formation, but five or six sandy limestone lenses near Alidami (northeastern Kahta–Adìyaman) are rich in rudists. These lenses are 0.5–4 m thick and 50–200 m long (Figures 4 and 6), and rudist biostromes are developed in the lower two lenses. Although rudists are dominant, large benthonic foraminifera, hermatypic corals, lamellibranchs, and algae are also present (Meriç et al., 1985). The rudist species *Vautrinia syriaca* (Vautrin) and *Vaccinites braciensis* Sladić–Trifunović are abundant and indicate a Maastrichtian age. *Pironaea anatolica* Karacabey suggests a middle Maastrichtian age (Özer, 1987, 1988a). The orbitoidal forams have been assigned a middle–late Maastrichtian age by Meriç (1987).

Similar deposition occurred in the Yayladagì–Antakya area, including rudist limestone lenses 0.5–1.0 m thick in clastics of the Alidami section (Figure 4). These rudists also indicate a Maastrichtian age (Özer, 1991); *Vautrinia syriaca* (Vautrin) is abundant.

Besni Formation

The lower part of the Besni Formation consists of yellowish gray sandstones 3–20 m thick with benthonic foraminifera, especially large *Loftusia* and some lamellibranches. Rudists are rare in the sandstones. A single layer of sandy limestone 1–1.5 m thick with large rudists has been observed near Eskikahta (Figure 4). Locally, *Biradiolites* forms small buildups.

The upper part of the Besni Formation is predominantly yellowish gray medium- to thick-bedded limestones 10–25 m thick (Figures 4 and 7). The limestones contain rudists, benthonic foraminifera, lamellibranchs, echinoids, gastropods, corals, and red algae. The Besni Formation also contains a few interbedded dolomitic

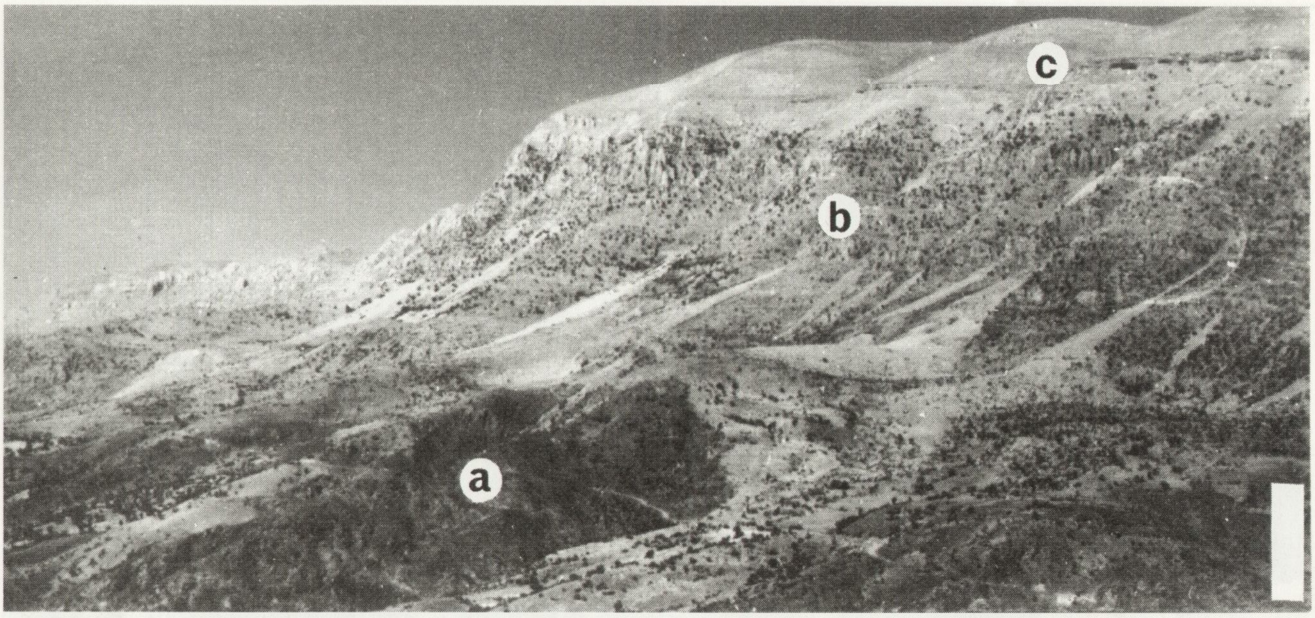

Figure 7. Panoramic view near Eskikahta village, Adìyaman, view toward the southeast. (a) Serpentinites of Koçali Complex limestones overlain by (b) the Besni Formation. (c) Clastics of the Gerçüs Formation of Eocene in age unconformably overlie the Besni Formation. The vertical scale is 150 m.

limestones. Some levels of the limestone consist of radiolitid fragments. Rudist biostromes are developed in the area surrounding Kahta.

The rudists of the Besni Formation indicate a Maastrichtian age. A late Maastrichtian age for the Besni Formation has been accepted by previous studies (Meriç, 1965; Sungurlu, 1974; Yalçìn, 1976; Perinçek, 1979; Meriç et al., 1986). A middle Maastrichtian age has been proposed by Özer (1987, 1988a) based on the stratigraphic positions of *Pironaea* spp. in Anatolia. Meriç (1987) assigned a middle–late Maastrichtian age to the Besni Formation on the basis of foraminiferal zones.

Germav Formation

The Germav Formation is made up of alternating grayish green shales, sandstones, and local conglomerates. The thickness varies from 50 to 200 m. The dominant shales are rich in planktonic foraminifera. Around Alidamì, three or four laterally persistent limestone bands 1–10 m thick were observed in the shales of the Germav Formation (Figures 4 and 8). The second band is a few kilometers long (Figures 6 and 8). Rudists are characteristic of these limestones; *Dictyoptychus euphratica* Karacabey-Öztemür is dominant. Lamellibranchs, corals, gastropods, and benthonic foraminifera are present locally. All of the faunal components are fragmented; rudists in life positions have not been found. In northwestern Diyarbakìr around Çermik (Figure 1), small-scale limestone lenses contain abundant fragments of *Pironaea praeslavonica* Milovanovic, Sladic, Grubic. A sample of Hippuritidae with three pillars, *Hippuritella (Tetracoinites)* sp., was also found. The age of the Germav Formation spans late Maastrichtian–Paleocene based on the planktonic foraminifera (Meriç et al., 1986; Özkan, 1986; Meriç, 1987).

PLATFORM TYPE

The Maastrichtian sequence of southeastern Anatolia consists of a transgressive systems tract exposed in the Terbüzek, Besni, and Germav formations. They were formed along a narrow belt having a slope on the northern side of the Arabian plate. The present east-west dimension of the shelf is about 300 km; its north-south dimension is up to 35 km wide. The platform is approximately 10–25 m thick in the updip area and as thick as 80–100 m in the downdip area to the south.

The transgressive facies represent an energy gradient on the distally steepened ramp ranging from high energy beach (shore) to shallow shelf and low energy basin environments (Figure 9). The direction of the gradients is toward the south.

The depositional facies indicate the presence of a low relief detrital platform at the beginning of the Maastrichtian transgression. High energy clastics, such as conglomerates and sandstones of the Terbüzek Formation, are localized near the shoreline of this platform. The rudist-bearing sandy limestone lenses within the clastics indicate the development of shallow marine conditions. Resistant bioclastic packstone lenses

Figure 8. (a) Outcrop of lime floatstone bed in (b) shales of Germav Formation. Siver village, near Alidamì-Adiyaman, view toward the southeast. Floatstone bed is 1–1.5 m thick.

are a few meters thick and contain both biogenic and terrigenous sand grains. Foraminifera, corals, echinoids, gastropods, algae, and rudists comprise the biogenic fragments. The presence of the coarse terrigenous materials suggests that high energy with clastic influx onto the platform continued during the deposition of the rudist limestone lenses. No typical rudist reefs have been recorded; however, some biostromes contain framestones of limited lateral extension formed by cylindrical or cylindrical-cone rudists such as *Vautrinia syriaca* (Vautrin), *Vaccinites braciensis* Sladiĉ-Trifunoviĉ and *Dictyoptychus* Douvillé.

The lower part of the Besni Formation consists of transgressive sandstones formed in shallow water, moderate energy conditions. The sandstone characterized by the large benthonic foraminifera indicate shallow marine conditions. The presence of some lamellibranch bivalves and rare rudists may support this interpretation. The absence of corals, gastropods, and algae may have resulted from terrigenous sedimentation inhibiting the development of these communities.

The upper part of the Besni Formation consists of shallow marine limestones. The termination of the terrigenous influx allowed the development of carbonate deposits rich in benthonic macro- and microfossils. No reef structure can be seen, except for some rudist framestones of limited lateral extent. These bedded biostromes were constructed by cylindrical rudists such as certain hippuritids (*Hippurites cornucopiae* Defrance) and radiolitids (*Vautrinia syriaca* Vautrin). The limestones are mainly bioclastic packstones, with grainstones being rare.

Carbonates of the Besni Formation are transitional with low energy pelagic shales of the Germav Formation. Three to four lime floatstone beds (Embry and Klovan, 1971) are laterally persistent in the shales and are a few kilometers long (Figure 4, Alidamì section). Some small floatstone beds also occur that are only 7–8 m long and 40–50 cm thick (around Çermik in northwestern Diyarbakìr). The floatstones contain matrix-supported rudists, corals, molluscs, and benthonic foraminifera that were derived from the Besni limestone. The matrix also contains pelagic fossils and shale clasts. Their occurrence indicates periodic density currents on the slope. The persistence of the pelagic shales of the Germav Formation into the Paleocene indicates the continuation of the transgression and the final drowning of the platform.

CONCLUSIONS

The Maastrichtian transgressive sequence of southeastern Anatolia was developed on a gently sloping, distally steepened carbonate ramp on the northern shelf of the Arabian plate. The shore line was essentially in an east-west direction, and the shelf faces south. The ramp includes beach and shallow shelf deposits with clastics and carbonates that grade seaward to basinal pelagic shales. The facies provide evidence for the drowning of a shallow ramp.

The carbonate shelf of southeastern Anatolia has no well-developed back reef lagoons, typical reefs, or

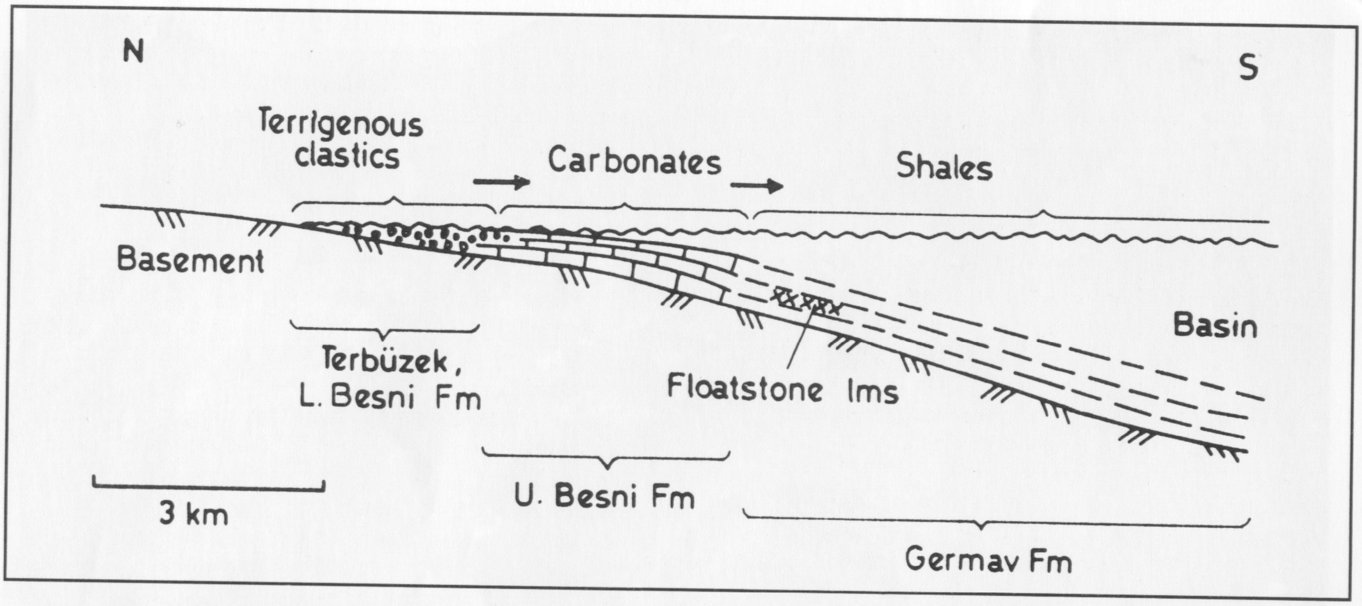

Figure 9. A sketch illustrating the morphology of the carbonate ramp and showing the variation in facies toward the south (arrows) from shore to basin in southeastern Anatolia.

striking breaks in slope. This indicates the development of a shallow ramp. The lime floatstone beds on the distal ramp are interpreted as slope turbidites rather than downslope buildups on a homoclinal ramp, such as those cited by Read (1985). The persistance of low energy basinal shales into the Paleocene suggests continued transgression and drowning of the ramp.

Some rudists of southeastern Anatolia, such as *Vautrinia, Dictyoptychus, Hatayia, Hippurites syriaca,* and *Pironaea syriaca,* are characteristic of the Arabian plate. These are endemic forms having a geographic distribution limited to Syria, Iran, and the Oman Penninsula (Özer, 1986, 1988b, 1991, 1992). Accordingly, the present author has called them "Arabian platform rudist fauna" (Özer, 1992).

A clastic-dominated shelf developed in southeastern Anatolia rather than a carbonate shelf (as in the Arabian shield, Mosul, Basrah, and Oman Gulf) (Wilson, 1975) because of tectonic activity in the adjacent Taurus orogenic belt.

Maastrichtian clastic influxes during transgression and rapid subsidence may have inhibited development of a shallow carbonate shelf occupied by rudist and other biostructures, such as those that flourished in western Taurus and southwestern Turkey (Gutnic et al., 1979; Özer, 1988b,c), around Izmir in western Turkey (Özer and Irtem, 1982; Özer, 1989; Erdogan, 1990), on the Apulian platform (Combes et al., 1981; Accordi et al., 1982; Sladic–Trifunovic, 1987; Camoin et al., 1988; Eberli et al., Chapter 18, this volume), and in the Provence region of southern France (Masse and Philip, 1981).

References Cited

Accordi, G., F. Carbone, and G. Sirna, 1982, Relationships among tectonic setting substratum and benthonic communities in the Upper Cretaceous of northeastern Matese (Malise, Italy): Geologica Romana, v. 21, p. 755–793.

Camoin, G., M. C. Bernet–Roland, and J. Philip, 1988, Rudist–coral frameworks associated with submarine volcanism in the Maastrichtian of the Pachino area (Sicily): Sedimentology, v. 35, p. 123–138.

Combes, P. J., E. Fourcade, J.-P. Masse, and J. Philip, 1981, Observations stratigraphiques et paléontologiques sur le Crétacé de la zone du Parnasse (Gréce): Travaux de l'ICSOBA, Aim Conférence, Cagliari, 1979, Edition Académie Yougoslavie et des Artes, Zagrep, n. 16, p. 347–365.

Dercourt, J., L. P. Zonenshain, L. E. Ricou, V. G. Kazmin, X. Le Pichon, et al., 1985, Présentation de 9 cartes paléogéographiques au 1/20.000.000 s'étendant de l'Atlantique au Pamir pour la périod du Lias àl'Actuel: Bulletin Société Géologique France, 8e Série, t. I, n. 5, p. 637–652.

Embry, A. F., and J. G. Kovan, 1971, A Late Devonian reef tract on northeastern Banks Island, Northwest Territories: Canadian Petroleum Geology Bulletin, v. 19, n. 4, p. 730–781.

Erdogan, B., 1990, Stratigraphy and tectonic evolution of Izmir–Ankara Zone between Izmir and Seferihisar: Turkish Association of Petroleum Geologists Bulletin, v. 2, n. 1, p. 1–20 (in Turkish).

Gutnic, M., O. Monod, A. Poisson, and J. M. Dumont, 1979, Géologie des Taurides occidentales (Turquie): Mémoire Société Géologique France, Nouvelle Série, t. LVIII, n. 137, 112 p.

Masse, J. P., and J. Philip, 1981, Cretaceous coral–rudist buildups of France, in D. F. Toomey, ed., European fossil reef models: SEPM Special Publication 30, p. 399–426.

Meriç, E., 1965, Etude géologique et paléontologique de la région entre Kahta et Nemrutdag (sud–est Anatolie): Revue de la Faculté des Science de l'Université d'Istanbul, t. XXVII, f. 1–2, Série B, p. 55–107.

Meriç, E., 1987, Biostratigraphical investigation of the Adìyaman area: Seventhth Biannual Petroleum Congress of Turkey, April 1987, Proceedings Geology, p. 141–153.

Meriç, E., F. Y. Oktay, and S. Özer, 1985, New observations on the stratigraphical development of Besni Formation to the northwest of Alidamì (Kahta–Adìyaman): Publication of the Chamber of Geological Engineers of Turkey, n. 25, p. 51–54 (in Turkish).

Meriç, E., F. Y. Oktay, V. Toker, I. Tansel, and N. Doruk, 1986, Biostratigraphical and sedimentological investigation of Upper Cretaceous–Eocene aged sedimentary sequence around Adìyaman: Abstracts of the Geological Congress of Turkey, February 1986, p. 46.

Özer, S., 1986, Faune de rudistes maestrichtienne de l'environ de Kahta–Adìyaman (Anatolie sud–est): Bulletin of Mineral Research and Exploration, n.107, p. 101–105.

Özer, S., 1987, Paleontology and stratigraphic distributions of the species of the *Pironaea* (rudists) from the Anatolia: Abstracts of the Geological Congress of Turkey, February 1987, p. 64.

Özer, S., 1988a, Paleontology and biogeography of the pironaean (rudist) species from the central-east-southeast Anatolia and Kocaeli Peninsula: Geological Bulletin of Turkey, v. 31, p. 47–58, (in Turkish).

Özer, S., 1988b, Distributions statigraphiques et géographiques des rudists du Crétacé supérieur en Turquie: First International Conference on Rudists 1988, Serbian Geological Society Abstracts, p. 16.

Özer, S., 1988c, Descriptions de quelques rudistes à canaux dans le Cénomanien de Turquie: Géologie Mediterranéenne, t. XV, n. 2, p. 159–167.

Özer, S., 1989, Sur une faune d'Hippuritides de calcaires du Crétacé supérieur de la zone d'Izmir-Ankara (Anatolie occidentale)—intérét paléontologique et stratigraphique: Revue de Paléobiologie, v. 8, n. 2, p. 335–343.

Özer, S., 1991, Maastrichtian rudist fauna and biogeography of the Yayladagì-Hatay area (SE Anatolia): Ahmet Acar Geology Symposium Proceedings, p. 145–152 (in Turkish).

Özer, S., 1992, Stratigraphic setting and biogeographic characteristic of rudists in SE Anatolia: Turkish Association of Petroleum Geologists Bulletin, v. 4, n. 1, p. 47–58.

Özer, S., and O. Irtem, 1982, Geological setting, stratigraphy and facies characteristics of the Upper Createaceous limestones in the Isìklar-Altindag (Bornova-Izmir) area: Bulletin of the Geological Society of Turkey, v. 25, p. 41–47 (in Turkish).

Özkan, S., 1986, Maastrichtian planktonic foraminifera and stratigraphy of the Germav Formation, Gerçüs area, southeast Turkey: Abstracts of the Geological Congress of Turkey, February 1986, p. 47.

Perinçek, A., 1979, Geological investigation of the Çelikhan-Sincik-Koçali area (Adìyaman province): Revue de la Faculté des Science de l'Université d'Istanbul, v. 44, Série B, p. 127–147.

Perinçek, A., 1990, Stratigraphy of the Hakkari province, southeast Türkiye: Turkish Association of Petroleum Geologists Bulletin, v. 2, n. 1, p. 21–68.

Read, J. F., 1985. Carbonate platform facies model: AAPG.Bulletin, v. 69, p. 1–21.

Righo de Righi, M., and A. Cortesini, 1964, Gravity tectonics in Foothills structure belt of southeast Turkey: AAPG Bulletin, v. 48, n. 12, p. 1911–1937.

Sladić–Trifunović, M., 1987, Pironaea–Pseudopolyconite Senonian of the Apulian plate—paleobiogeographic correlations and biostratigraphy: Memoria Societa Geologia Italiana, v. 40, p. 149–162.

Sungurlu, O., 1974, Geology of the northern part of petroleum District—VI: Second Petroleum Congress of Turkey, Proceedings, p. 84–107.

Wilson, J. L., 1975, Carbonate Facies in Geologic History: New York, Springer–Verlag, 470 p.

Yalçìn, N., 1976, Geology of the Narince-Gerger area (Adìyaman province) and its petroleum possibilities: Revue de la Faculté des Science de l'Université d'Istanbul, v. 41, n. 1–4, Série B, p. 57–82.