GENERAL GEOLOGY OF THE AREA DEFINED BY THE POLYGONE BALABAN-YAZIHAN-KURŞUNLU-LEVENT (VİLAYET MALATYA)

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ABSTRACT. — The area of study is characterized by thick sedimentation. The oldest formations, which incidentally were not mentioned in the reports so far, are represented with limestones we refer to as «comprehensive series» and beginning from the Jurassic. They come as high up as Cretaceous. Eocene formations with a basal conglomerate unconformably overlie the comprehensive series. Miocene series overlying the Eocene, which is distinguishable from the Lower to Upper Eocene, is widespread in the area. These formations were under the effect of various phases of the Alpine orogeny.

INTRODUCTION

This paper covers part of the results of field work carried out in 1961. 1:25,000-scale topographic maps K38-c_3 and K38-c_4 were used during this study. Detailed presentation of some of the data obtained during this investigation will be attempted in the following paragraphs.

We owe many thanks to those who did their share in the preparation and publishing of this paper.

LOCATION

The area of study covers some 300 km^2 and lies toward the northeast corner of the 1:100,000-scale map-section 79/3. Boundaries are defined by Kabaca, Yazıhan in the northeast, Kurşunlu in the north (an administrative subdivision of Hekimhan), Balaban in the southwest (subdivision of Darende) and Levent in the south (subdivision of Akçadağ). Tohma River runs by the south of the area. Malatya - Hekimhan highway lies to the northeast and Malatya - Kayseri highway to the south of the area of study.

GEOGRAPHY

The area under study occupies a region between southeastern and eastern Taurus Mountains. Mean altitude is about 1400m, with the highest point Göktepe (1884m). There are no important plains, but only small-scale flat areas mostly on a few eroded hill tops. Cut up. with deep valley, the area has a rough and mountaneous structure.

Drainage system (dendritic type) includes Tohma River and a number of smaller streams and creeks feeding it. Tohma River follows an antecedent-type valley. Guided by the character and position of the strata, it gives typical examples of obsequent, transversal and also anticlinal valleys. Such features as devil's pots and cataracts, in addition to crescent side banks, succession of small island-like structures along the

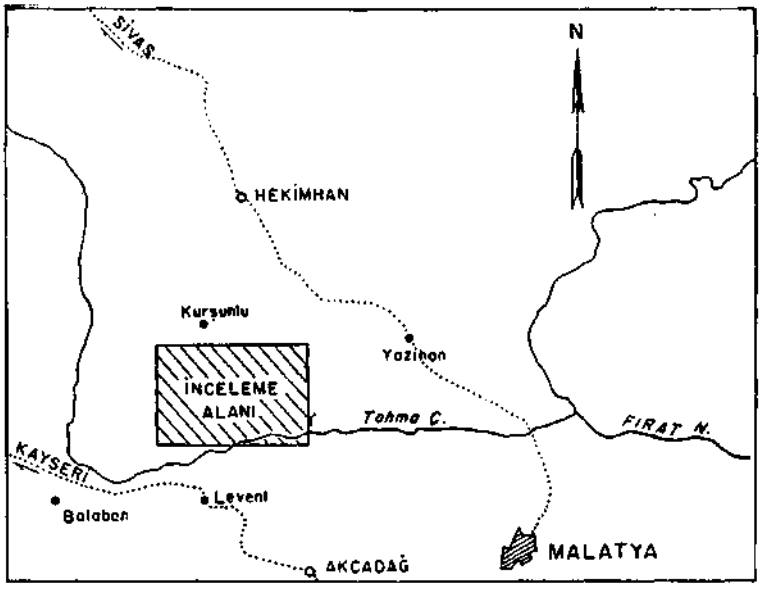


Fig. 1 - Map showing location of the area studied.

middle line of the stream, fillings and flood plains are often present. On the slopes of the valley sides cornishes and cuestas are formed. In these streams the quantity of flow does not remain fixed, but shows seasonal changes.

PREVIOUS STUDIES

The following studies were carried out on different occasions within the area covered by the map-section 79/3.

V. Stchepinsky widely studied this region in 1944 and wrote about Permo-Garboniferous, Senonian, Paleocene, Oligocene and Sarmatian sediments in his report entitled «The geology of the northern Malatya region and its mineral resources». In the course of this study he described the formations cut by the Tohma River as Lutetian-Auversian.

D. Wirtz visited the area in 1954. In his «Report on geological mapping in the Tohma River region, Malatya» he presented the Tohma River valley as Middle Eocene flysch, the mouth of Levent Creek as Paleocene limestone and southern and northern parts as marine Lower and Middle Miocene. Marls and limestones of the Middle Eocene were called the «upper Arabian facies».

Ibrahim Akarsu reviewed D. Wirtz's geologic map in 1956. Limestones shown by him as Burdigalian and Vindobonian actually belong to the richly fossiliferous Lutetian.

Both 1. Akarsu and D. Wirtz marked the Koru Dağı as built of basalt and marly kaolin.

In 1951 a second revision was carried out in the region by T. E. Gattinger. On the maps made by other geologists, Koru Dağı was shown as covered by basalts. However, Gattinger, making revision of this map, pointed out that the actual location of the basalt was not at the Koru Mountain but at Göktepe, while Koru Dağı is

composed of various Eocene formations and Upper Cretaceous sediments. He also indicated presence of a fault running N-S, which cuts through the east slope of the mountain.

STRATIGRAPHY

I. Jurassic - Cretaceous limestones

Comprehensive series. — It stretches from west to east in the Tohma valley, forming a strip 1 km wide. This series, also visible in the valleys of Ebreme, Halavun and Levent rivers, is the oldest formation in the area. It comprises hard limestone beds with light tan and reddish gray intercalations. These limestones contain calcite veins and occasionally show perfect stratification. They are typically fine-grained, argillaceous and partly dolomitic. Basal section is not visible. The series is strongly folded and broken up. Serpentines cut through the limestones. Evidence of contact metamorphism is observed. Being hard, these limestones were resistant to erosion. Thus on both sides of the Tohma valley a rough-looking topography took shape.

Determination work undertaken by T.F.J. Dessauvagie on rock specimens brought in, showed the presence of a comprehensive series reaching from Jurassic to Upper Cretaceous. Microfossils found were very small-and displaying gradual change and perfect regularity. *Lithologic age determination is not possible.* The fossils below were determined by T.F.J. Dessauvagie :

Valvulammina
Ostracoda
Pfenderina
Nodosariidae
Vaginulina
Ammodiscidae
Valvulinella jurassica Henson
Clypeina jurassica Favre

II. Upper Cretaceous flysch

On both sides of the Tohma valley in the study area, lies an Upper Cretaceous formation, which is mostly formed of plastic material comprising fine elastics and reef

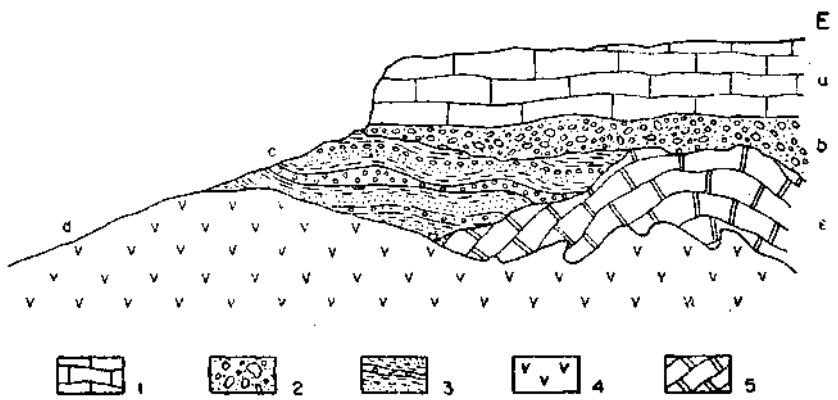


Fig. 2 - Neighborhood of Benli Mezrası

1 - Eocene limestone; 2 - Eocene basal conglomerate; 3 - Upper Cretaceous flysch; 4 - Greenstone; 5 - Limestone belonging to comprehensive series.

limestones. At the basal part lies a green conglomerate formed by loosely cemented serpentine pebbles and gravels. These pebbles and gravels are of varying sizes and larger Cretaceous limestone gravels are also present within the conglomerate. Here are found sandstone bands with intercalations of conglomerates. The sandstones contain macrofossils. Conglomerates show a gradual passage into shales. These shales are well stratified and variegated and contain numerous macrofossils, such as :

Hippwites (Orbignya) colliciata Woodward
Actaeonella aff. *gigantea* d'Orbigny
Natica
Pecten
Cyclolites

Upper Cretaceous reef limestone lenses are encountered in these shales. The limestone, in lenticular form just mentioned, is hard and of gray and white color, occasionally sandy and argillaceous. It is rich in macrofossils. The shales once again pass into conglomerates in the upper layers. Only the components of this second conglomerate are mostly Cretaceous gravels and pebbles.

In view of the presence of the fossils named above, the age of this formation was determined by C. Kırağlı and N. Karacabey to be Maestrichtian and Campanian or more generally Senonian.

III. Lower Eocene

Lower Eocene unconformably overlying the Upper Cretaceous formations begins with a basal conglomerate. This latter is formed by Lower Cretaceous, Jurassic and Upper Cretaceous pebbles and gravels. Binding element, cement, is again limestone and the gravels are remarkably- well-cemented. Various shades of pink color are predominant. Certain characteristic features are displayed by conglomerates from place to place in the area of study. In thicker sections' gravels are round or subround, while in thinner sections they are either angular or sub-angular, nearly resembling breccia.

Especially in the eastern part of our area Ypresian limestones overlie the Eocene basal conglomerates. Rocks here are mostly limestones which are partially pseudo-oolitic, schistous, microcrystalline and slightly argillaceous. Texture is crystalline and crypto-crystalline in the bottom parts. The Ypresian limestones mentioned conformably underlie the Lower Lutetian limestones, containing shale and clay. No macrofossils were encountered in these limestones. As for microfossils, those determined by E. Sirel, indicative of Paleocene (?) Ypresian age, are listed below :

Alveolina cf. *subpyrenaica* Leymerie
Lockhartia conditi Nuttal
Nummulites globulus Leymerie
Nummulites atacicus Leymerie

IV. Middle Eocene

a. Lower Lutetian. — Lower Lutetian limestones and shales conformably overlie Ypresian limestones in our area of study. Lower layers of this formation consist of limestone strata in which clay content increases going from bottom upward. In the upper parts are yellowish white shale beds alternating with thin argillaceous limestone and very thin reddish gray sandstone layers.

These characteristics are best observed in such localities as the Çırçır pass, Çalkan Dere and Angar rock outcrops.

Determination of fossils by E. Sirel, named below, helped place this formation within the Lower Lutetian :

Operorbitolites sp.
Orbitolites sp,
Somalina
Orbitolites complanatus Lamarck
Alveolina oblonga d'Orb.
Nummulites uroniensis A, B A. Heim
Nummulites globulus Leymerie

b. *Middle (?) Lutetian*. — Lutetian beds show different types of facies in the eastern and western sections of the area of study. Middle Lutetian in the Ebreme and Tohma valleys conformably overlie the Lower Lutetian shales and limestones.

Here, Lutetian begins at the base with shales containing limestone and argillaceous limestone intercalations forming thin layers. In the middle and upper layers are yellowish limestone beds containing schist and clay with argillaceous limestone bands. Typical texture of these limestones is either cryptbcrystalline or pseudo-oolitic.

Their age was determined as being Lutetian after examination, by E. Sirel, C. Öztemür, S. Erk and A. Nazlı, of rock specimens which were found to contain fossils listed below :

Nummulites aturicus Joly & Leym. (Form B)
Nummulites uroniensis A. Heim
Fabianina cf. *cassis* Oppenheim
Nummulites rouaulti d'Archiac
Rhapidionina cf. *uroniensis* Henson
Lucina aff. *immanis* Oppenheim
Lucina corbaricus Leymerie

According to the stratigraphic indications, this series probably belongs to the middle parts of the Lutetian and localities displaying best sections are İğdeli - Ünür and Kanlı Dere, whereas along the Halavun Stream and to the east of it a Lower Lutetian limestone series overlies the basal conglomerate, which continues up to the Upper Lutetian without show of any lithologic variation.

c. *Upper Lutetian*. — Upper Lutetian strata conformably overlie Middle Lutetian layers. Their basal sediments consist of alternating shale and argillaceous limestone beds. Upper strata are built of partially dolomitic limestones with thin shale bands. Here limestones and shales show lateral facies changes. They are very rich in both micro and macrofossils. Some of the shales contain carbonaceous schists and lignite deposits of no economic importance. They also contain bands of claystone, siltstone and sandy limestone.

E. Sirel identified the following fossils :

Chapmanina gassinensis (Silvestri)
Nummulites contortus (Deshayes)
Meretrix sp.

Age determined was Upper Lutetian.

V. Upper Eocene

Priabonian (?). — Upper Lutetian strata in our area of study show a gradual passage into limestones, sandy limestones and shales of the Upper Eocene. Change in lateral facies may be clearly observed in the region. For example, there is a thick limestone series lying near Bakacakkas, south of Tohma, covering the entire Eocene, whereas in the vicinities of Kanlı Dere and partly Akkaya Stream the Upper Lutetian formation shows passage into a formation of alternating layers of marine and continental sediments. This series comprises argillaceous limestones and shales with siltstone intercalations at the bottom, showing lateral passage into fossiliferous limestones, irregular beds of sandy and argillaceous limestones in the middle, and white shales containing chalky limestone beds on top.

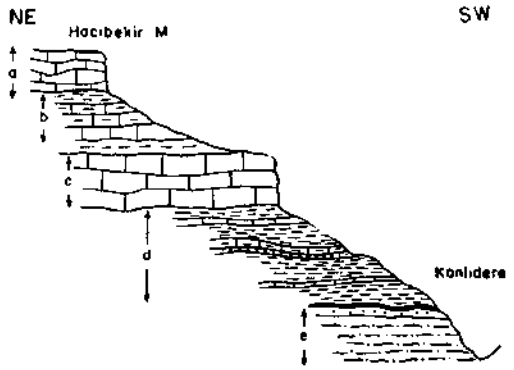


Fig. 3 - East side of the Kanlı Dere Stream

a - 100 m thick limestone *(Burdigalian)*; b - 50-70 m thick shale - argillaceous limestone *(Burdigalian)*; c - 100 m thick limestone *(Upper Lutetian)*; d - 60 m thick shale - sandy shale - argillaceous limestone *(Lutetian)*; [50-80 cm thick lignite *(Lutetian)*]; e - 2 m thick sandy clay and siltstone *(Lutetian).*

Rock specimens collected in the area were examined by E. Sirel, C. Öztemür and A. Nazlı, and the fossils below helped to set the formation's age at Priabonian or more generally Upper Eocene :

Halkyardia minima Liebus
Meretrix aff. *incrassata* Sowerby
Lucina aff. *prominensis* Oppenheim

VI. Oligocene

Upper Oligocene (?) - Lower Miocene- — There are no clearly defined Oligocene formations in the area under study. Only between the Upper Eocene and Burdigalian strata there lies a transition bed, some 50 meters thick. This formation built of yellowish sandstones and argillaceous limestones in alternating layers, paraconformably overlies the Upper Lutetian or Priabonian and displays a gradual transition towards and into the Burdigalian.

Çavuş Mahallesi offers a good locality for observation. Fossils found here were :

Operculina complanata Defr.
Amphistegina radiata Fichtel & Moll
Archaias

Hence the age was estimated by C. Öztemür to be Upper Oligocene (?) - Lower Miocene.

VII. Miocene

Miocene formations cover quite a large area mostly in the northern parts of our region. Burdigalian marine sediments overlie sandy-argillaceous limestones of the Upper Oligocene - Lower Miocene (Aquitanian). Burdigalian formations from the bottom up show distinct horizons of :

a) Sandstone - sandy limestone,
b) Argillaceous limestone,

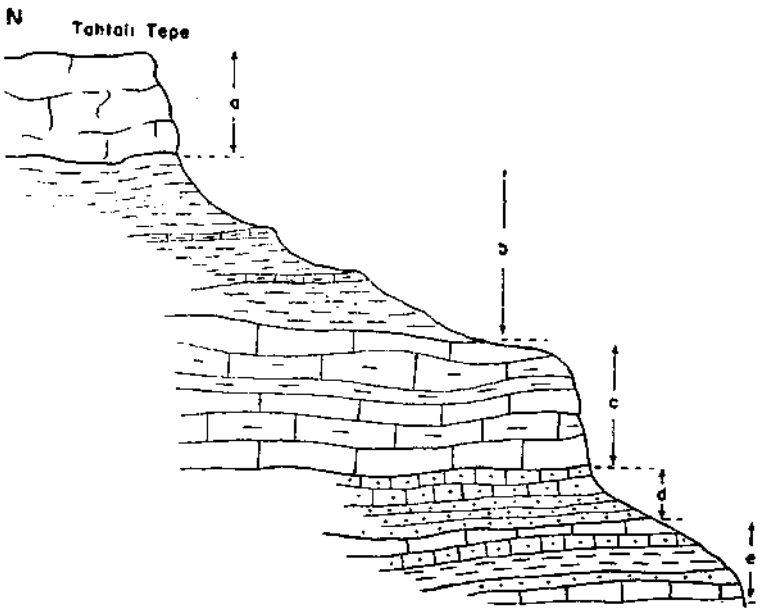


Fig. 4 - Miocene stratification in general

a - Cavernous limestone *(? Upper Burdigalian - Helvetian)*; b - Shale - argillaceous limestone *(? Middle Burdigalian)*; c - Argillaceous limestone *(Burdigalian)*; d - Sandstone - sandy limestone *(Burdigalian)*; e - Sandy limestone - argillaceous limestone - shale *(Upper Oligocene - Lower Burdigalian)*.

c) Shale,
d) Limestone.

a) Sandstone - sandy limestone : A thin sandstone - sandy limestone bed conformably lies between Upper Eocene and Burdigalian limestone strata. It is coarsely built and of yellowish color with layers generally horizontal. Age estimated was Burdigalian, because of *Lucina globulosa* (Deshayes) determined by L. Erentöz and M. Türkünal.

b) Argillaceous limestone : It overlies the sandstone - sandy limestone bed. It is hard, fine-grained and of a yellowish color, with intercalations of white clay and limy shales. Layers mostly horizontal display occasional gentle dipping. Both micro and macrofossils are abundant. The microfossils. listed below were determined by C. Öztemür :

Miogypsina sp.
Operculina complanata Defr.
Amphistegina radiata Fichtel & Moll

while the following macrofossils, indicating the Burdigalian age, were determined by L. Erentöz :

Chlamys multistriatus Poli
Pecten aff. *corsicanus* Deperet & Roman
Lucina pragilis Philippi

c) Shale : This is a soft, thick, yellowish-white shale formation with very fine argillaceous limestone intercalations. It overlies conformably the argillaceous limestone formation in the northern part of our area. Shales are in general exposed to excessive erosion and often form agricultural soil throughout the region.

Marine marl deposits are also encountered here and there, showing intercalation with shales. The following fossils, collected from these marls, indicative of Burdigalian age, were determined by J. M. Sellier de Civrieux :

Spiroplectammina carinata (d'Orb.)
Sigmoilina tennis (Czjzek)
Lenticulina (Robulus) calcar (Linne)
Lenticulina (Robulus) orbicularis (d'Orb.)
Lenticulina (Robulus) dicampyla (Franzenau)
Lenticulina (Robulus) arcuato-striata (Hantken)
Ostracods
Gastropods

d) Limestone : Limestone strata overlie this soft series in various parts of the northern section of the area studied. They are yellowish and white in color and form thick, hard layers, cavernous at times. Only few fossils are found. None of the macrofossils were sufficiently distinctive to allow an age determination. Macrofossils below were determined by C. Öztemür :

Miogypsina irregularis (Mich.)
Miogypsina saitoi (Yabe & Hanzawa)
Miolepidocyclina (?)

VIII. Pliocene

Loose gravels of various sizes and shapes are encountered in several places within the area under study. These mantle rocks include gravels often with rounded or blunt corners, indicative of rolling, material consisting of basalt, Miocene limestone, Nummulitic Eocene limestone, Jurassic - Cretaceous limestone, serpentinite and radiolarite. Taytaşı and Taşlıharman are typical locations where these observations can best be verified.

IX. Quaternary

Accumulation forms. — Alluvium mantles formed with coarse sand and pebbles lie in the Tohma and Halavun valleys.

A couple of terraces can be distinguished in the valley of Gelengeç Stream.

Destructional forms. — Throughout the entire area alluvial cones formed of different-size loose gravels and fallen rock fragments are often encountered. Their dimensions vary with the type of original rock formation, degree of alteration (weathering), steepness of slope and intensity of the moving force.

Best examples will be found east of Karamağara and in the surroundings of Kadiribrahim village.

Karstic topography is also represented in the area and examplified by such caves as those of Ulukaya, Karadelik and İn, where stalactites, stalagmites and dripstones are found.

A thick layer of soil has formed on the flat tops of eroded hills.

MAGMATISM

Eruptive rocks

Serpentines. — Serpentines usually form small outcrops in several places of the area under study. These, as a rule, are serpentinized basic and ultrabasic (plutonic) rocks. A comparatively fresh specimen brought in from southern parts of the area was defined as a gabbro composed of large plagioclase crystals and uralitized (actinolitized) augite.

It generally looks as though these plutonic rocks are in the course of time serpentinized. Serpentines posses a network texture and to some extent contain chromite.

In a specimen collected from the Alagöz Tepe, a diabase, which was partially turned to chlorite, serpentine and silica, was defined as diabase-spilite. Together with serpentines abundant occurrence of radiolarite and ironstone is common.

Effusives

Basalts. — Only those seen in the Göktepe region overlie the Miocene marls and limestones. They are alkaline and rich in olivine. Age: post-Miocene.

TECTONICS

Effects of Alpine movements are visible in the area. Limestones of the comprehensive series were folded along an E-W axis during the Lower and Upper Cretaceous (Austric phase - Vorgosau).

Much folded and broken up structure, as seen today, must be the result of Laramian phase movements that occurred after the close of late Cretaceous, possibly between Senonian and Paleocene periods. During this phase some faulting took place, cutting the folds up in an approximate north - south direction. Greenstones penetrated the limestone strata through cracks, which occurred as a result of initial magmatic activity phase of the Laramian.

Depression areas formed under epeirogenic movements following the Laramian orogeny were later filled by shallow sea transgression sediments of the Eocene time. These sediments are horizontal, or nearly so, indicating a rather undisturbed Pyrenean phase, compared with the surrounding areas. Epeirogenic movements which took place at the close of Eocene resulted in alternating marine and continental sedimentations. There is no well - defined formation from the Oligocene period in the area of study, as the sedimentary rocks which settled during the epeirogenic movements — continuation of the Helvetic phase —- were already eroded. Thus, this paraconformity was formed between the Upper Eocene and Upper Oligocene.

There is no unconformity observed between Upper Oligocene and Lower Miocene sediments indicating that the Savic phase was not effective in the region. As the Burdigalian strata still keep their horizontal position, it is evident that the old Steiric phase did not affect the area either. Only in a few places gentle foldings and monoclines dipping at most 10° are noticed.

Stratigraphic Column

Era	*System*	*Series*	*Stage*	*Lithology*
Quaternary	—	—	—	Alluvium
CENOZOIC	PLIOCENE	—	—	Pebble, gravel
	MIOCENE	LOWER MIOCENE	Upper Burdigalian	Limestone
			Middle Burdigalian	Shale
			Burdigalian	Shale, with intercalations of argillaceous limestone
			Lower Burdigalian	Sandstone - sandy limestone
		UPPER OLIGOCENE		Alternation of sandy - argillaceous limestone layers
		Para-conformable		
		UPPER EOCENE	Oligocene Priabonian	Alternating layers of sandy limestone, limestone and argillaceous limestone (containing lignite)
	EOCENE	MIDDLE EOCENE	Upper Lutetian	Limestones, shales and their lateral facies passages
			Lutetian	Shale with limestone intercalations
			Lower Lutetian	Shale with fine sandstone and argillaceous limestone intercalations
		LOWER EOCENE	Ypresian (Paleocene)	Limestone
		Angular discordance		Basal conglomerate
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS Angular discordance	Senonian	Flysch
	CRETACEOUS	UPPER CRETACEOUS	Campanian	Comprehensive limestone series
	JURASSIC	—	—	

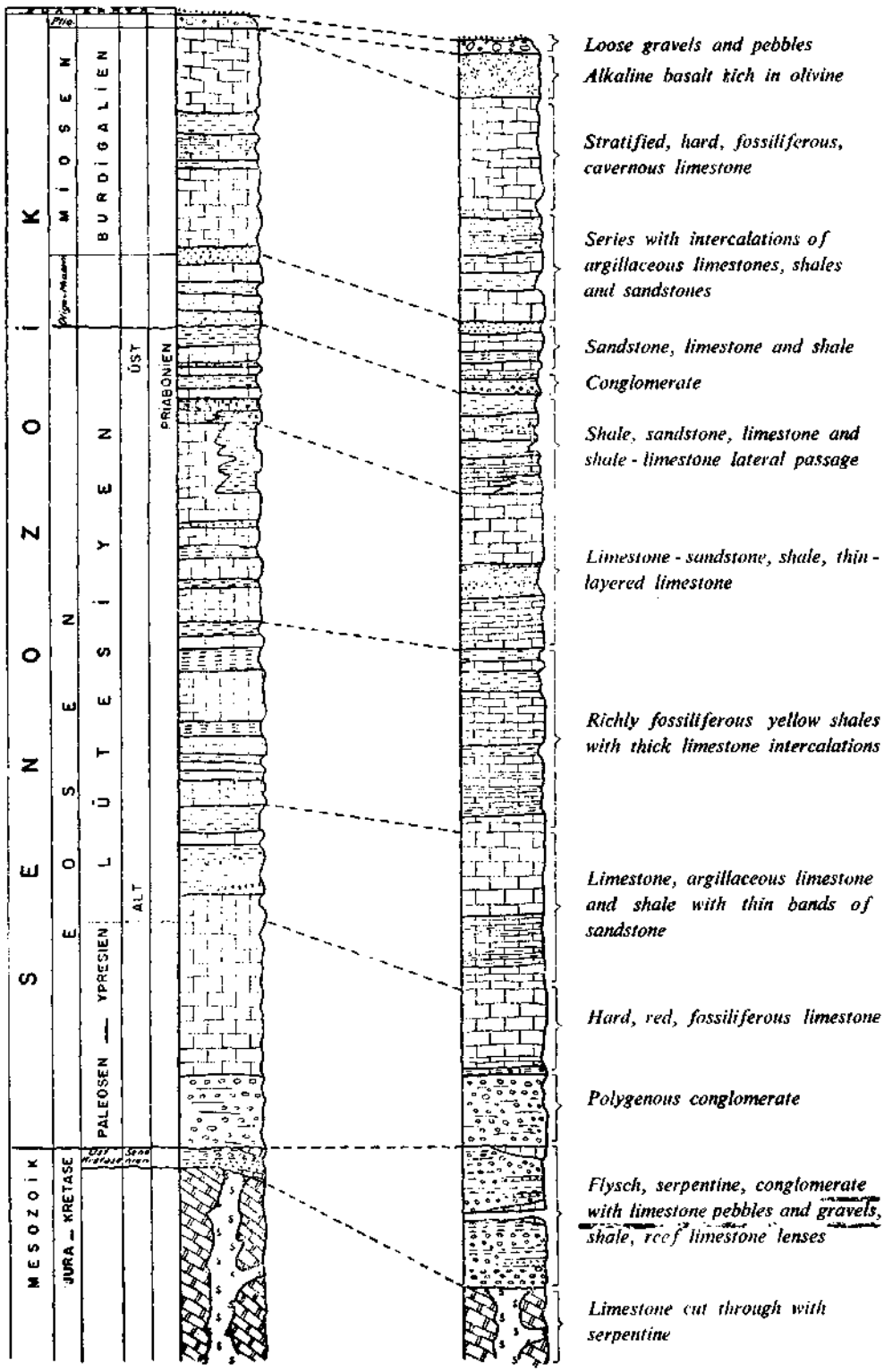


Fig. 5 - Stratigraphic column of the area. Scale : 1/4 500

Photo 1 - A view of Germik Dere.

Photo 2 - A cut by the Kocaağaç Stream. Above, Eocene limestones form cornishes. Upper Cretaceous flysch is stratified, disturbed from place to place by landislides.

Photo 3 - Eocene limestones lying north of the village of Kalolar and the unconformably underlying Upper Cretaceous flysch.

Photo 4 - Eocene limestone just to the north of Fatmacık village and one of the springs at the contact of Upper Cretaceous flysch.

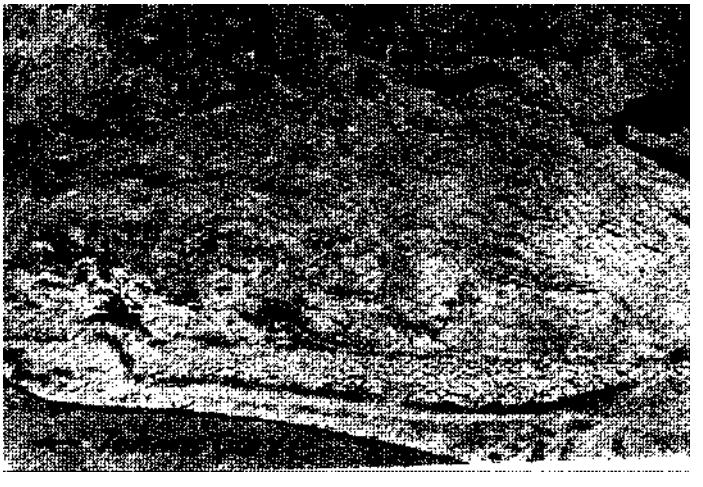
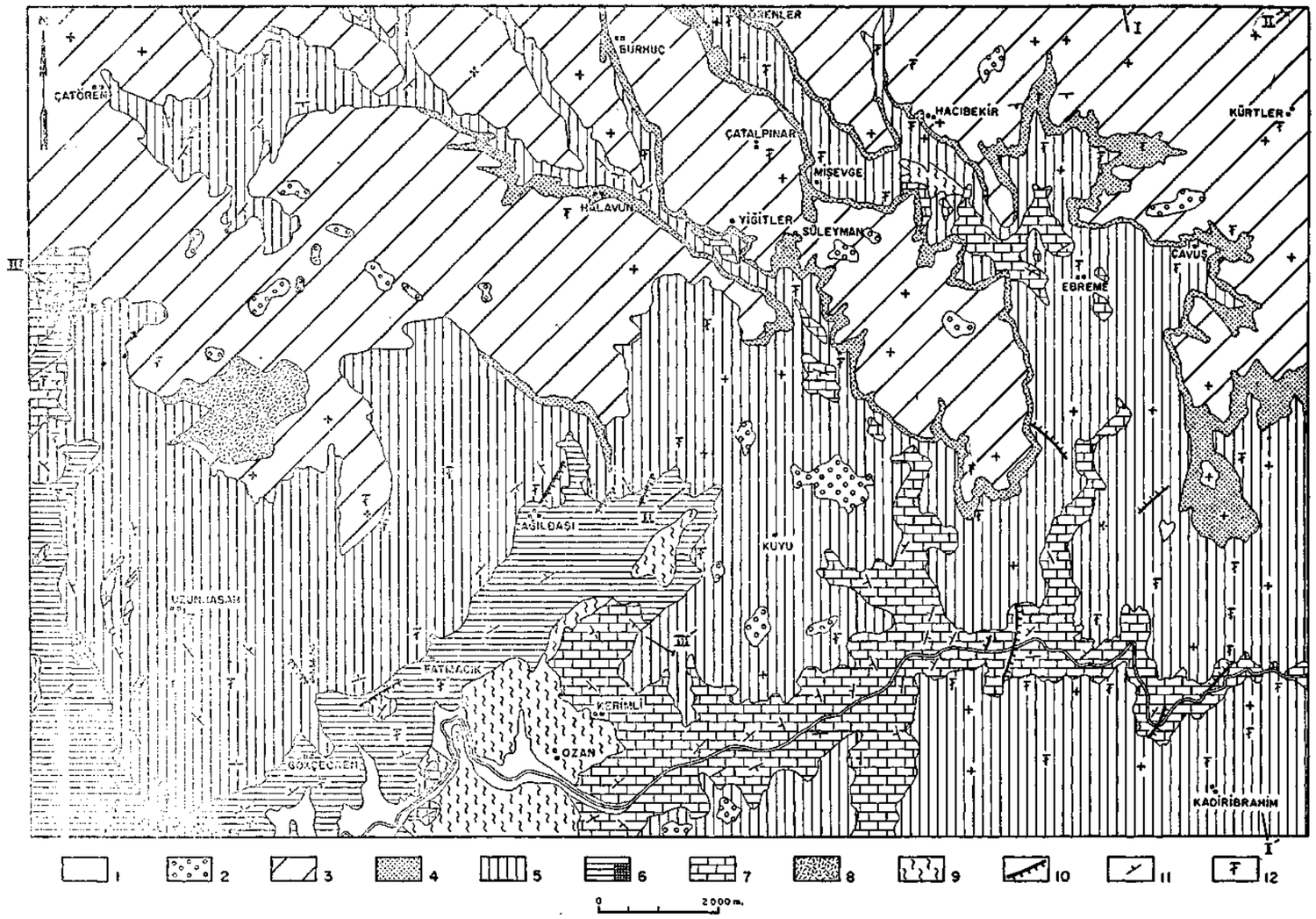


Photo 5 - Folded structure of the Lower Cretaceous limestone at the Köşkkaya locality.



GEOLOGICAL MAP OF THE REGION BETWEEN BALABAN, YAZIHAN, KURŞUNLU AND LEVENT

1 - Quaternary alluvium; 2 - Pliocene; 3 - Miocene; 4 - Oligo-Miocene; 5 - Eocene; 6 - Upper Cretaceous flysch and reefy limestone; 7 - Jurassic-Cretaceous limestone; 8 - Basalt; 9 - Serpentines; 10 - Fault; 11 - Dip-strike; 12 - Fossil locality.

There being found no younger sediments than those of the Burdigalian time in the area under study, any effect of younger Alpine orogenic phases —- namely new Steiric, Attic, Rhodanic and Passadenian — is very doubtful.

Accordingly, Alpine movements must be responsible for the present geologic structure of the area.

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