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GEOLOGY AND TECTONIC CHARACTERISTICS OF THE GÜRÜN AREA

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ABSTRACT. — The area under investigation is located S of Sivas, between Gürün and Uzunyayla, where carbonate sediments occur predominantly. Oldest rocks represented in the study area are Permo-Carboniferous limestones, overlain by the Jurassic and Cretaceous limestones and marl and shale beds. Tertiary begins with Eocene conglomerates unconformably resting upon the Mesozoic and comprises of Eocene limestones, sandstones and shales. Neogene lacustrine limestones, conglomerates and shales comprising the uppermost part of the section rest upon older formations unconformably. Magmatic activities are represented by andesite and basalt lavas.

The area under investigation lies within the Taurid tectonic unit, with folding tectonics being dominant throughout the area. The area was strongly fractured during the later stages.

INTRODUCTION

The writer has started his studies in the present area in 1963, within the framework of a general petroleum exploration programme. Interesting geology of the area, has led the writer to resume detailed research workin the following years, i.e. in 1974 and 1977, with a specific purpose to elucidate the stratigraphy and tectonics. Studies were carried out on 1:25 000 scale topographic maps and where necessary detailed profiles were used. Western extensions of the formations occurring in the area under investigation were determined on the basis of maps prepared by Akkuş, Beekman and Canik.

The writer deeply appreciates and expresses his gratitude to the authorities of the General Directorate of the Mineral Research arid Exploration Institute, M.T.A., without whose support and assistance, this work could not have been completed.

The writer further wishes to thank to Mr. C. Öztemür, Mrs. M. Serdaroğlu, Mr. E. Sirel, Mr. Z. Dağer, Mr. Y. N. Pekmen, Mr. S. de Civrieux, and Mr. T.F. J. Dessauvagie for determining fossils collected from various formations and to Mr. O. N. Ergun for sedimentological analyses of some samples and finally to Mr. O. Öztunalı for petrographic determinations.

GENERAL GEOLOGICAL SETTING

The area under investigation lies N of Gürün, situated S of Sivas Province (Fig.1), and has, in broad lines, the appearance of a high plateau. Streams intersecting the area, locally form deep canyons, and the major part of the region comprises of barren rocks.

Tohma Creek, most important stream intersecting the area, runs through Gürün town following an E-W direction, draining into River Fırat.

STRATIGRAPHY

Permo-Carboniferous, Jurassic-Cretaceous, Upper Cretaceous, Eocene, Neogene and Quaternary formations are represented in the present area (Plates I, II and III).

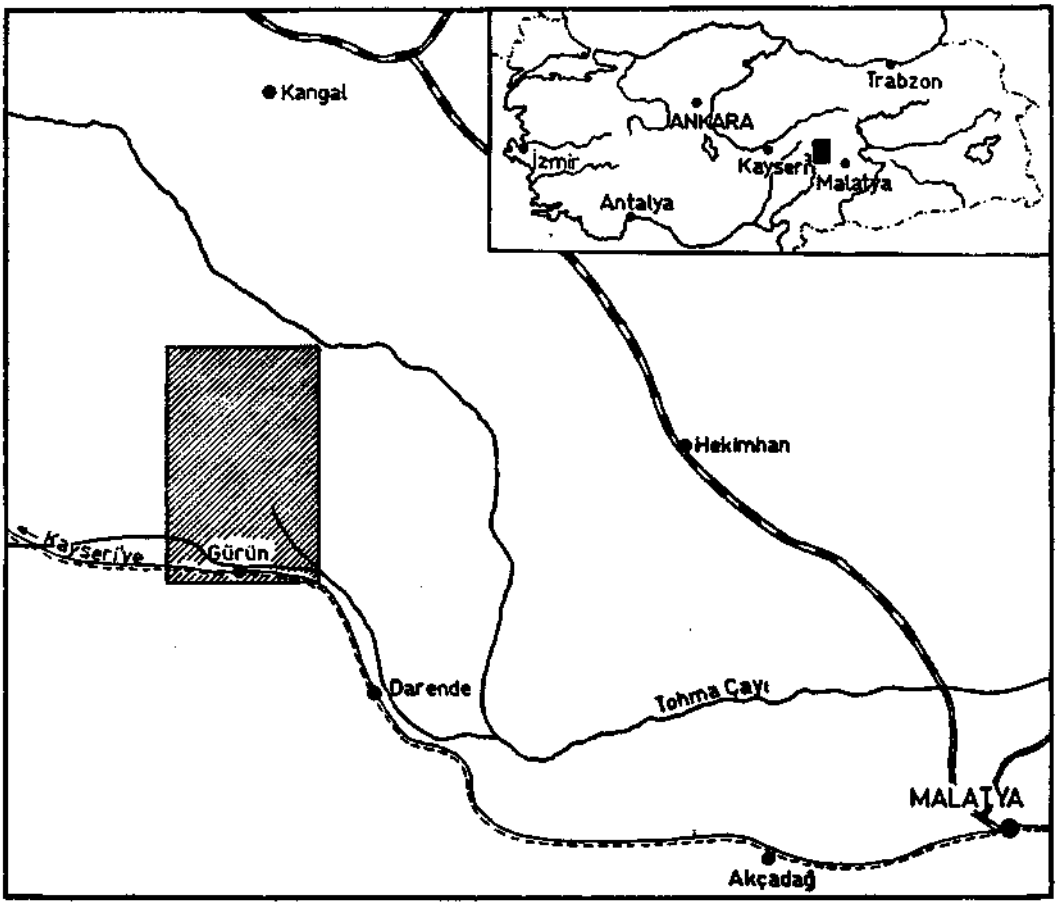

Fig. 1 - Geographical position of the survey area.

1. Permo-Carboniferous

Üçkoyakformation. — Oldest rocks represented in the area under investigation are represented by Permo-Carboniferous limestones, which are termed after Üçkoyak Hill located to the northwest, where they are best exposed as a large thrust fault. Two faults striking NE-SW bound the formation, which is massive and comprises of dark gray to black colored detritic limestones. White colored calcite veins occur very widespread. Macro and micro organisms are not very uncommon. In the lower levels, the formation grades into unfossilliferous sandstones.

Fossils determined by T.F.J. Dessauvagie are as follows:

Eostafella sp.

Reichelina

Plectogyra sp.

Hemigordiopsis

Ammodiscus sp.

Glomospirella

In addition to the microfossils listed above, the formation contains Brachiopoda and Corallia, and based on these, the age of the Üçkoyak formation is assumed to be Upper Permian to Lower Carboniferous.

The presence of Permo-Carboniferous formations in this part of the Tauruses was also reported by Blumenthal (1944). Akkuş (1963) and Beekman (1963) have further reported the occurrence of Permian and Permo-Carboniferous sediments in the same area.

2. Jurassic-Cretaceous

Horasançal formation. — Occurs very widespread in the northern half of the area under investigation (Plate I) forming high and barren ridges. Horasan9al formation comprises of limestones, which are essentially light gray colored and well-bedded in the lower levels. Limestones occurring in the upper levels of the Formation are poorly bedded and white colored. The uppermost section of the Horasan9al Formation comprises of massive, white to pink colored limestones, containing abundant calcite veins. Intensive fracturing has led to the formation of karstic depressions. Since Triassic Formations found elsewhere, are not observed between the Permo-Carboniferous Üçkoyak Formation and Horasançal Formation, it has been concluded that the latter rests upon the Permo-Carboniferous unconformably.

Although certain bedding features could be observed from a distance, measurements could not be made due to the absence of bedding planes and the effects of weathering observed on the surfaces. When examined closely, dolomitization, however locally, and small chert nodules and fossil fragments may be observed. According to O.N. Ergun, foraminifera and skelatal fragments constitute 30-40 % of the micritic matrix and secondary fracture fillings are common. Ergun further reports that the formation was deposited in a shallow sea environment, at a considerable distance from the coast.

Fossils are poorly represented in the Horasançal Formation, with macrofauna being almost absent. Microfauna, on the other hand, is also very scarce.

Fossils determined by Serdaroğlu, in the samples collected from the Horasançal Formation, are as follows:

Valvutinella jurassica Henson
Protopeneroplis sp.
Trocholina sp.
Eggerella sp.
Pseudocyclammina sp.
Cuneolina cylindrica Henson
Vidalina hispanica Schlum
Orbitoides tissoti Schlum
Minouxia lobata Gendrot
Valvulinidae
Ophthalmidiidae
Textularidae

Based on the fossils listed above, Jurassic-Upper Cretaceous age may be assigned to the Horasançal Formation (Plate III). Kurtman and Akkuş (1974), report that the Jurassic-Cretaceous limestones occur very widespread in the Malatya-Gürün area.

3. Upper Cretaceous

a. Düğünyurdu formation. — Düğünyurdu Formation occurs very widespread in the area under investigation (Plate I) occupying most part of the plains and cultivated areas.

This formation, essentially gray, light gray, beige and locally reddish in color and comprising of thin shale and marl beds, contains in the upper parts thin sandstone and sandy limestone layers, and overlies the Horasançal limestones unconformably. Maximum thickness of the formation is measured to be 500 meters in the northeastern part of the area; towards southwest, however, thinning is apparent. The transition between Horasançal and Düğünyurdu formations is not abrupt. Düğünyurdu formation gradually passes into the marl and limestone and marl and shale beds.

Düğünyurdu Formation contains abundant microfauna. Fossils determined by Serdaroğlu and Dessauvagie are as follows:

Globotruncana area (Cushman)

Globotruncana area contusa (Cushman)

Globotruncana stuarti

Gümbelina plummerae Loetterle

Marsonella oxycona

Gandryina sp.

Anomalina sp.

Bolivinoides

Velascoensis

Based on the fossils referred above, Upper Cretaceous, i.e. Maestrichtian age is assigned to Düğünyurdu Formation (Plate III).

b. Konakpınar formation.— This formation is termed after Konakpınar village, where it is best exposed. In the near vicinity of Konakpınar village, the formation, which is essentially gray to beige colored, consists of brecciated limestones. In the southern part of the area, the limestones are characterized by biomicritic texture, and it may therefore be concluded that an environmental change is in question from north to south. Limestones occurring in the northern part of the area, i.e. in the vicinity of Konakpınar village, are reef type, indicating to a shallow sea deposition environment. To the south, however, limestones occurring near Kalaycı Hill, reflect deposition in a deep sea environment. Orbitoides media containing limestone beds occurring in the north, grade into Globotruncana bearing limestones in the south.

Fossils determined by Dager and Dessauvagie in the samples collected from the surroundings of Konakpınar village are as follows:

Orbitoides media (D'Arch.)

Orbitoides apiculata Schl.

Simplorbitoides gensacius (Deym.)

Omphalocyclus macroporns Lam.

Siderolites

Lofrusia

Fossils identified by Serdaroğlu in the samples taken from Kalaycı Hill locality, the southern extension of the present formation, are given below:

Globotruncana sp.

Gümbelina globosa Ehren.

Globigerina sp.

Globotruncana globigerinoides Brotzen

Globotruncana linnei d'Orb.

Rotalia trochidiferais (Lamarck)

Miliolidae

Lituolidae

Based on the fossils identified, Maestrichtian age may be assigned to Konakpınar Formation. Limestones occurring in the present area, do not show transition into Paleocene, as is the case in the Sivas and Hekimhan areas (Kurtman, 1973; İzdar, 1963).

4. Eocene

a. Yukarısazcağız formation. — This formation, outcropping in the central part of the area, is termed after Yukarısazcağız village, where it is best seen. The formation consists of light gray colored and bedded limestones, containing abundant Nummulites and lamellibranch and begins with red and buff colored basal conglomerates SW of Yukarısazcağız village. Conglomerates are mostly represented by Jurassic-Cretaceous and Upper Cretaceous pebbles. Yukarısazcağız Formation overlies older formations unconformably and pinches out towards south where it shows lateral transition into the overlying Aşağısazcağız Formation: In the northern part of the area under investigation, however, the formation described here is absent and it may therefore be concluded that the Yukarısazcağız formation, representing the lowermost unit of the Eocene, was deposited in a shallow sea environment around an old hinge line and within a narrow area.

Sedimentological analysis of a sample collected from the Yukarısazcağız Formation was carried out by O.N. Ergun. According to Ergun, the Formation consists of biomicrite or biosparymicrite. Micrite matrix, containing scattered fragments of foraminifera, corals and algae, constitutes 40 percent: Secondary vein fillings are abundant. Calcite crystals, formed as a result of the recrystallization of micrite matrix are also very common. The sample studied represents deposition in a shallow sea environment, possibly on a shelf.

Fossils identified by Pekmen and Sirel in the samples collected from this formation are as follows:

Nummulites cf. *lucasi* d'Arc.

Nummulites cf. *laevigatus* Brug.

Aheolina sp.

Nummulites helveticus Kauf.

Discocyclina sp.

Operculina sp.

Globigerina

Based on the fossils identified, Lutetian age is assigned to Yukarısazcağız Formation.

b. Aşağısazcağız formation. — This formation occurs extensively in the SE part of the area and further outcrops to the NE and SW. It is termed after Aşağısazcağız village, where it is best seen. Aşağısazcağız Formation consists of alternating sandstones, shales, sandy limestones and marls, its color being gray to beige. The Formation shows flisch character and is well folded.

To the SE of the area under investigation,-Aşağısazcağız Formation overlies Yukarısazcağız limestones conformably. In the NE and SW however, it rests upon the Mesozoic formations unconformably. Sandy limestone beds are best developed in the northeast part ofthe area, in particular.

Fossils identified by Sirel in the samples taken from the Aşağısazcağız Formation are as follows:

Nummulites sp.

Discocyclina sp.

Asterigerim cf. *rotula* (Kauf.)

Globigerina

Triloculina

Quinqueloculina

Textularia

An age extending from Upper Lutetian into Upper Eocene can be assigned to Aşağısazcağız Formation on the basis of fossils listed above and in view of the fact that it overlies and shows lateral transition into the Lutetian limestones. Akkuş (1970), Pisoni (1964) and Wirtz (1955) report that the same formation crops out in the Tohma Valley, near Darende.

5. Neogene

Gürün formation. — This formation is termed after Gürün town, located S of the area under investigation, where it is best seen. Gürün Formation, starting with a conglomerate level, composed of Cretaceous and Eocene limestone pebbles, comprises of thin-bedded lacustrine limestones, shales, marls and tuffs. Occasionally the formation is intercalated with gypsum beds, and basalt sills. Limestones, in particular are platy. Maximum thickness of the Gürün Formation, light gray, yellowish to buff in color, is measured to be 700 - 800 meters in the near vicinity of Gürün town.

Gastropoda and Ostracoda are found in the formation. Age determination, however, could not be made, although the samples collected from the Gürün Formation were examined by Öztemür. Conglomerates, of continental origin, are locally exposed in the central and northern parts of the area and these show close resemblance to the conglomerates occurring at the base of the Gürün Formation. Although locally, fresh water limestones may also be found, and these are assumed to be the northern extentions of the formation under consideration. The writer considers the Gürün Formation, a lacustrine deposit.

Sedimentological analyses of the samples taken from the limestone beds of the Gürün Formation were made by O.N. Ergun, who considers these limestones «carbonate mudstones». Elliptic nodules, consisting of large calcite crystals also occur locally. The formation represents deposition in a quiet and evaporitic environment.

6. Quaternary

In the area under investigation, Quaternary is represented by alluvial deposits. Alluvial deposited on the banks of Tohma Creek, running through Gürün town, comprise the most important Quaternary deposits occurring in the present area.

IGNEOUS ROCKS

Volcanites

Andesite and basalt lavas are exposed in the area under investigation. Karadağ located S of Konakpınar village, is composed of andesite lavas, and the samples taken from this locality are identified as hornblende andesite by Öztunalı. According to Öztunalı, the samples analyzed consist of zonal plagioclase and hornblende phenocrysts in a matrix composed of plagioclase, hornblende and less glass. Volcanites occurring in the vicinity of Otlukilise iron ore deposit, located W of Karadağ, are also identified as hornblende andesite, containing frequent ore phenocrysts (Gümüş, 1964).

Black colored basalt lavas are exposed in the form of sills, developed within the Neogene found in the area between Çayboyu borough and Suçatı village (telin), located E of Gürün. Lavas occurring in the present area must have erupted, immediately W of Suçatı, as the lava sills developed within the beds indicate to a eruption center in this part of the region. At the contact between the sedimentary beds and the sills, the effects of contact metamorphism are evident. Necks, connecting the sills can also be observed locally.

The samples taken from this locality were determined by Öztunalı as pyroxene basalt mandelstone.

The age of the andesite and basalt lavas outcropping in the area under investigation is assumed, to be Neogene, since the basalt lavas occurring further to south, intrudes Gürün Formation of Neogene age. Karadağ andesites may also be Neogene, or even older, i.e. Eocene. It should however, be borne in mind that these rocks are younger than Cretaceous since they intersect the latter.

TECTONICS

1. General

The tectonic setting of Anatolia is very complicated. Several authors, e.g. Arni (1939), Egeran (1947) and Ketin (1966), have attempted to divide the region into tectonic units, on the basis of tectonic similarities observed.

The present area under investigation lies within the Taurid tectonic unit, characterized by the Alpine orogeny, and is bound in the north and south by the Anatolid tectonic unit characterized by metamorphic massifs and intrabasins and marginal folds showing foredeep character, respectively.

In view of the «Anatolian transversal tectonics» (Pajeras, 1940), the area under investigation is situated within the Malatya depression, which is bordered in the east and west by the Van and Kızılırmak uplifts, respectively.

2. Folds

Formations occurring in the present area are more or less bedded. Bedding features of the Jurassic-Cretaceous limestones, however, can only be distinguished from a distance. Upper Cre-

taceous shales and marls, Eocene sediments showing flisch character and the Neogene Gürün Formation, on the other hand, are well-bedded. Folding developed in these formations, is also very conspicious, whereas in the Mesozoic and Tertiary limestones, it may only be traced in broad outlines. In the present area, folding is the most important and conspicious tectonic feature. Permo-Carboniferous formations however, are characterized by monoclinal structures developed as a result of thrust faulting.

Although the Jurassic and Cretaceous formations and Eocene and Neogene were affected by different phases of folding, the strike of folding is parallel. Folding axes, however, show the effects of a virgation. Folding axes striking WSW-ENE in the western part of the area under investigation, extend NW-SE in the east (Plate IV). This characteristic feature, which may be clearly traced on the tectonic maps, is also reflected by the diagrams representing the two different parts of the area. Mean axial strike and dip of the Eocene beds occurring in the western part of the area, are determined to be N70°E and 4°WSW, respectively, on the basis of the Schmidt diagram (Fig. 2). In the eastern part of the area, however, mean axial strike and dip of the Eocene formations are determined to be N30°W and 2°NWN, respectively (Fig. 3).

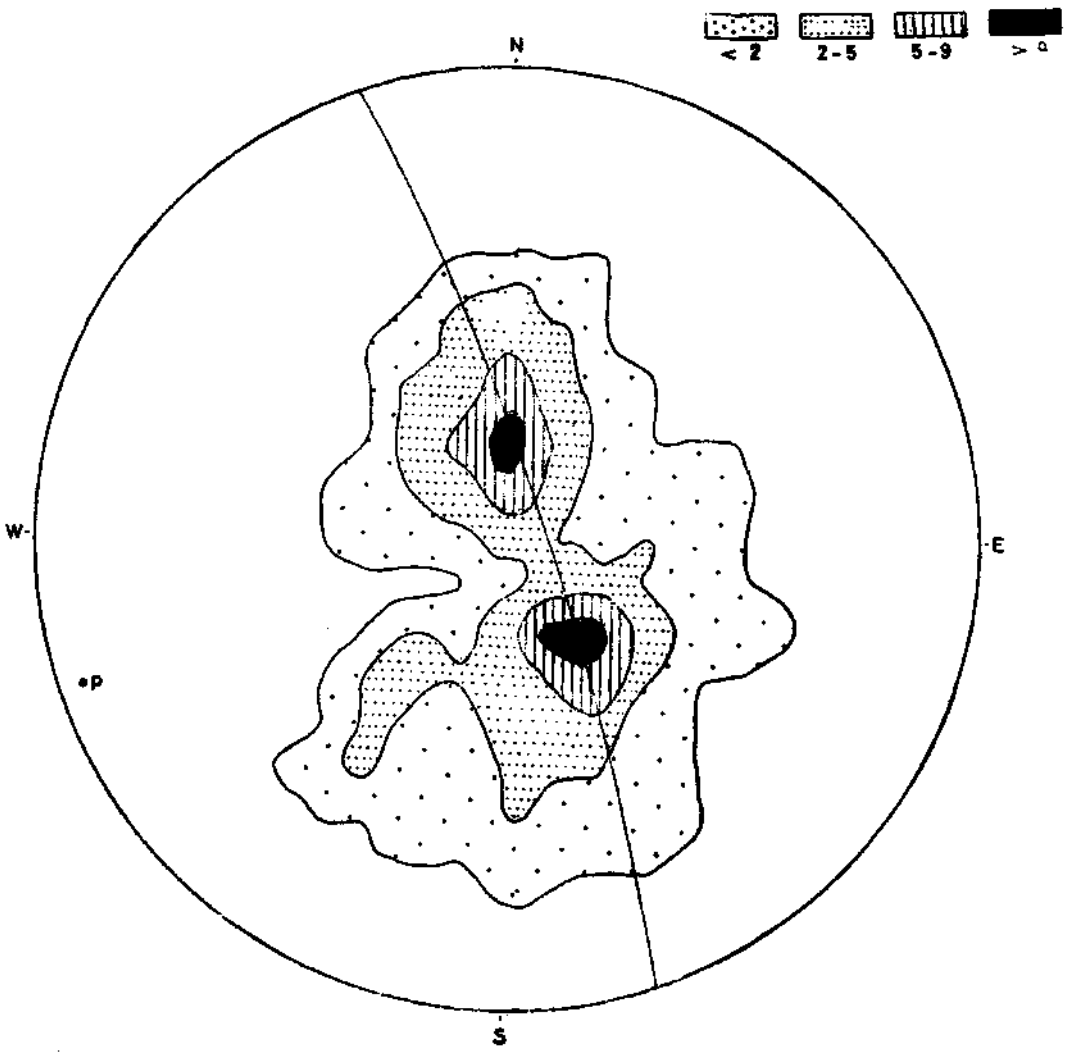

Fig. 2 - Schmidt diagram showing bedding and mean fold axis in the west.
P-Fold axis. Measurements: 63.

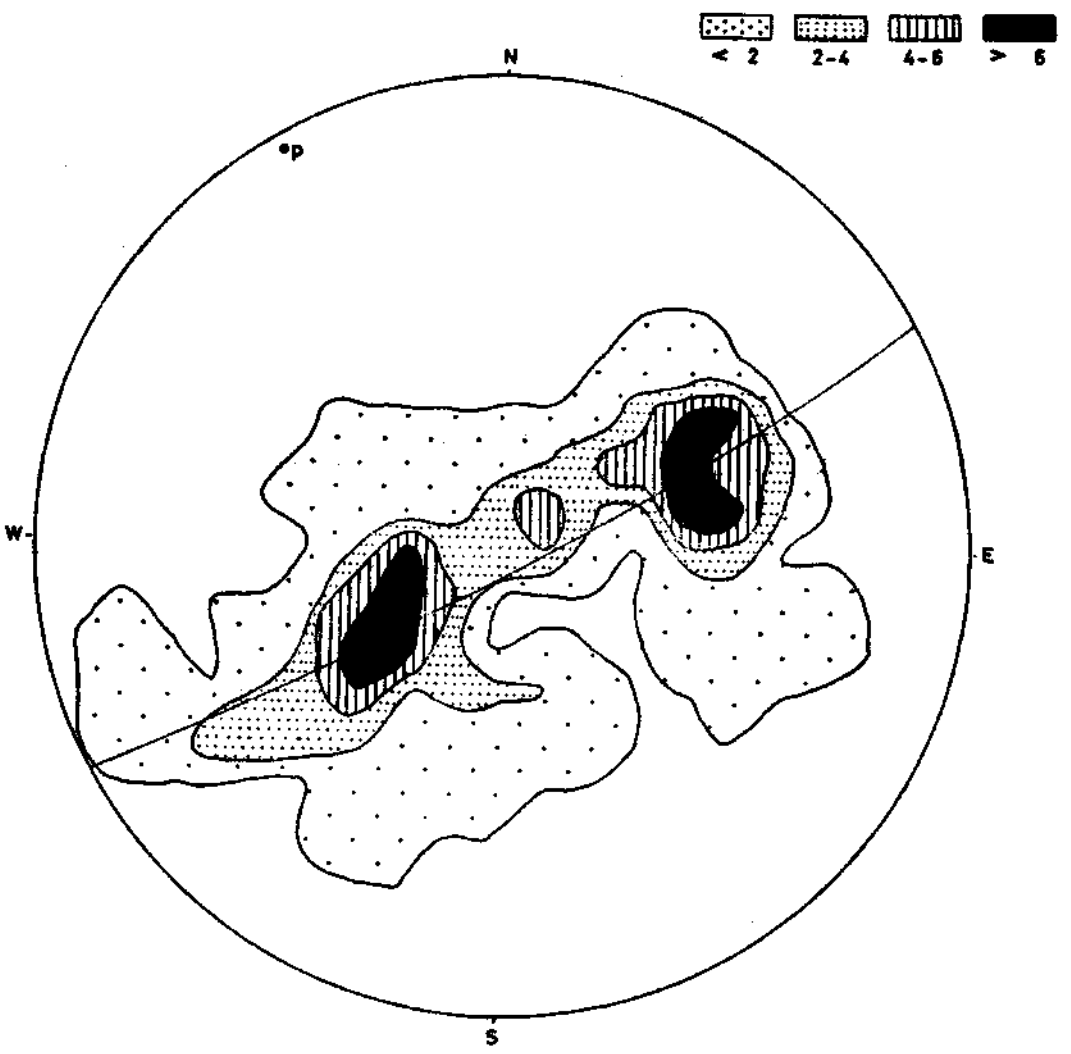

Fig. 3 - Schmidt diagram showing bedding and mean fold axis in the east.
P-Fold axis. Measurements: 62.

The strike of formations occurring in the western half of the area, coincide with the general tectonic trend of the Tauruscs. Axial rotation, measured to be 70° - 80° in the area E of Gürün, however, indicates to a considerable virgation. NW-SE trend of the folding axes can be traced as far as Malatya, through Darende. The effects of virgation can hardly be seen in the northern parts of the area. Folding axes extending WSW-ENF, coincide with the general tectonic trend of the Tauruses, with the Keban massive, located further to E, being developed in between. In all probability, Keban massive is responsible from the Gürün virgation.

3. Joints

Rocks exposed in the present area, are more or less jointed, depending on their lithological and other physical features. Joints developed in the limestone and sandstone beds, in particular, are very pronounced.

Rose diagrams prepared on the basis of measurements made on the bearing of joints developed within the Jurassic-Cretaceous aged Horasançal Formation, Eocene Yukarısazcağız Formation and Neogene limestones, are evaluated on tectonic maps (Plate IV). The comparision of diagrams, indicates that the formations effected by the Laramian and Pyrenian phases, show close similarities. In such formations, dominant jointing direction is determined to be NW-SE; their relation to folding, however, cannot be established clearly. In the Gürün Formation, on the other hand, affected by the Attic phase, dominant folding direction extends N-S and it may therefore be concluded that the tectonic effects leading to the development of joints in the Gürün Formation, are different.

4. Faults

In the area under investigation and its surroundings two major fault zones (Plates I,II and IV), are observed. Faults zones developed N of the area and immediately NW of Gürün, strike SW-NE or WSW-ENE. These zones comprise of gravity or strike-slip faults.

Faults observed in the eastern part of the area under investigation strike N-S, originating further to south with a thrusting in the direction of east (Plate IV). The same fault zone, comprises of strike-slip faults in the N part of the area also, and may be closely related to the virgation effecting the folding axes, since it lies almost perpendicular to the tectonic orientation, dominant prior to virgation. In the west however, folding axes and faults strike parallel.

5. Orogenic movements

In the present area, the oldest orogenic movements are represented by the Hercynian orogeny (Plate IV). Permo-Carboniferous and Devonian Formations outcropping in and around the area under investigation, are assumed to have been folded during the Hercynian orogeny, active in this part of the Tauruses (Brinkman, 1976). The relationship the Permo-Carboniferous formations and the Jurassic limestones however, cannot be established, since their contact is faulted. To the west however, an unconformity exists between these formations (Kurtman & Akkuş, 1974).

The earliest known Alpine movement affecting the area, has taken place at the end of Cretaceous. Jurassic-Cretaceous Horasançal Formation, Upper Cretaceous Düğünyurdu and Konakpınar formations were deposited conformably and folded at the end of Cretaceous. These are overlain by the Eocene formations unconformably. As Paleocene and Lower Eocene do not occur in the area, it may therefore be concluded that the region was affected by the Laramian phase of the Alpine orogeny, at the end of Upper Cretaceous.

The area was further affected by the orogenic movements occurring at the end of Eocene, as indicated by the Eocene sediments, which are folded at the end of Eocene, by the Pyrenean phase of the Alpine orogeny. Neogene sediments, on the other hand, overlie Eocene with an angular unconformity (Plate II).

Neogene Gürün Formation was folded during the Attican Phase of the Alpine orogeny, representing the youngest orogenic movement in the present area.

Folding is absent in the Quaternary alluvial deposits. The development of terraces, however, indicate that the epirogenic activities were more or less effective, although on a limited scale.

PALEOGEOGRAPHY

As indicated by the presence of Permo-Carboniferous outcrops, the area under investigation was invaded by the seas at the end of Eocene and throughout Carboniferous. Continental conditions are assumed to have prevailed within the presert area, however for a very short time, during the end of Paleozoic, since Triassic is absent. Shallow sea conditions prevailed in the area from Jurassic through the end of Upper Cretaceous. At the end of Upper Cretaceous, the northern part of the area under investigation was invaded by shallow and warn seas favoring the development of reefs, as contrasted to the deep seas to the south.

The seas regressed from the area by the end of Mesozoic, and during Paleocene no deposition look place. The area was invaded by the seas again during the Eocene. Conglomerates and limestones occurring at the base of Eocene are assumed to have been deposited in a shelf environment. From Middle Eocene to the end of Eocene active marine conditions prevailed in the area, which favored the deposition of sediments showing flisch character. The area was uplifted by the end of Eocene, thus becoming a continent, with some lakes being preserved as small depositional basins. Lakes were dried up by the end of Neogene and the present-day geographical features of the area were developed.

CONCLUSIONS

The results obtained from the present study carried out in the Gürün area may be summarized as follow:

1. 1:25 000 scale detailed geological map of the area was prepared.

2. Oldest rocks occurring in the present area are Permo-Carboniferous.

3. Mesozoic sediments occurring very widespread in the present area are classified into three units on the basis of their lifhological features and fossils contained.

4. Eocene is also represented in the present area, and can be divided into two units on the basis of fossils contained and lithological features.

5. Thick lacustrine sediments also occur in the present area; they are assigned Neogene age, as they lack characteristic fossils.

6. Young basalt and andesite lavas occur in the area.

7. The area was effected by the Laramian, Pyrenean, and Attican phases of the Hercynian and Alpine orogenies.

8. Folding axes strike SW-NE in the western part of the area, whereas NW-SE in the east, as a result of virgation.

9. Two major fracture systems, extending SW-NE and N-S are developed in the present area.

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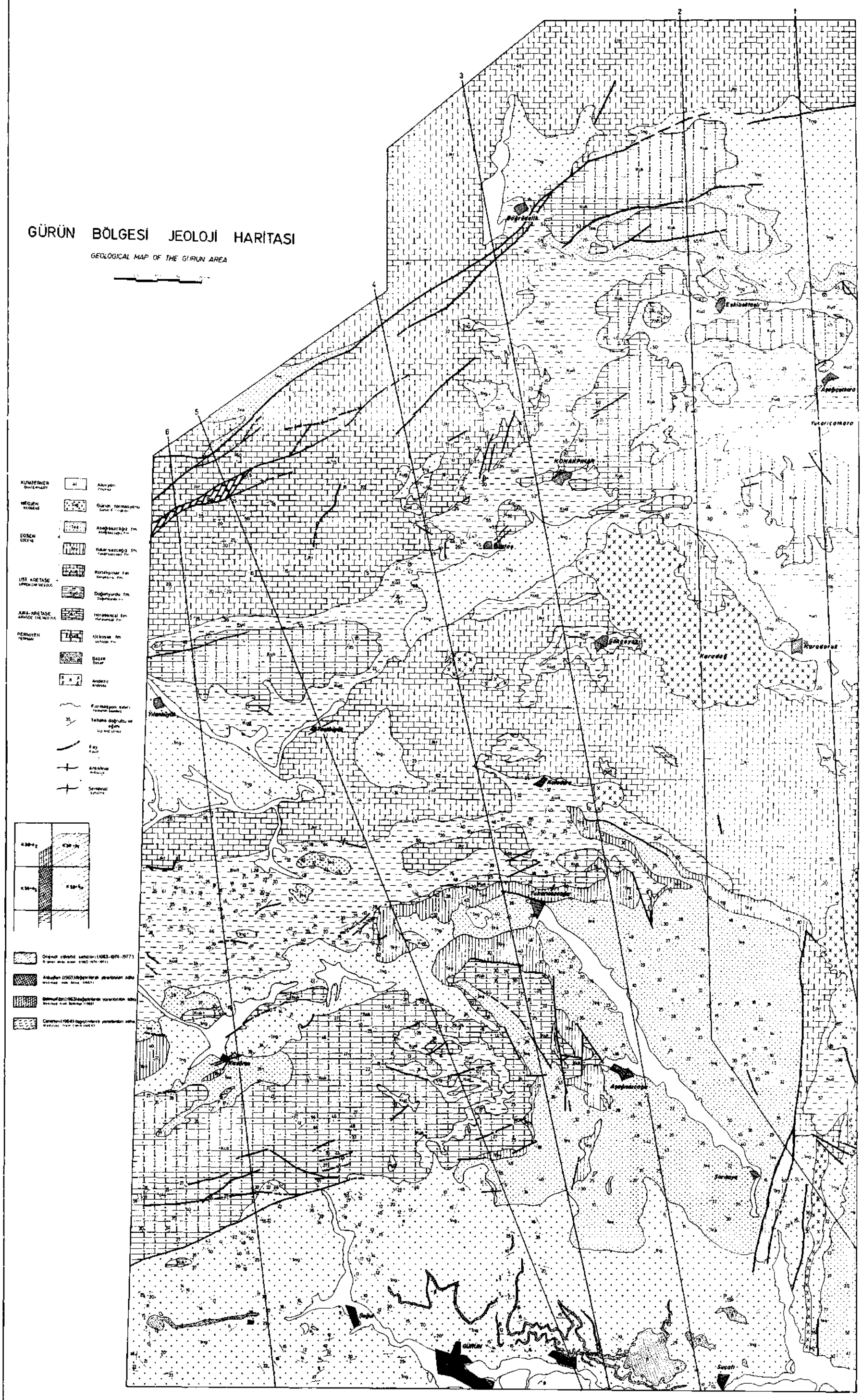
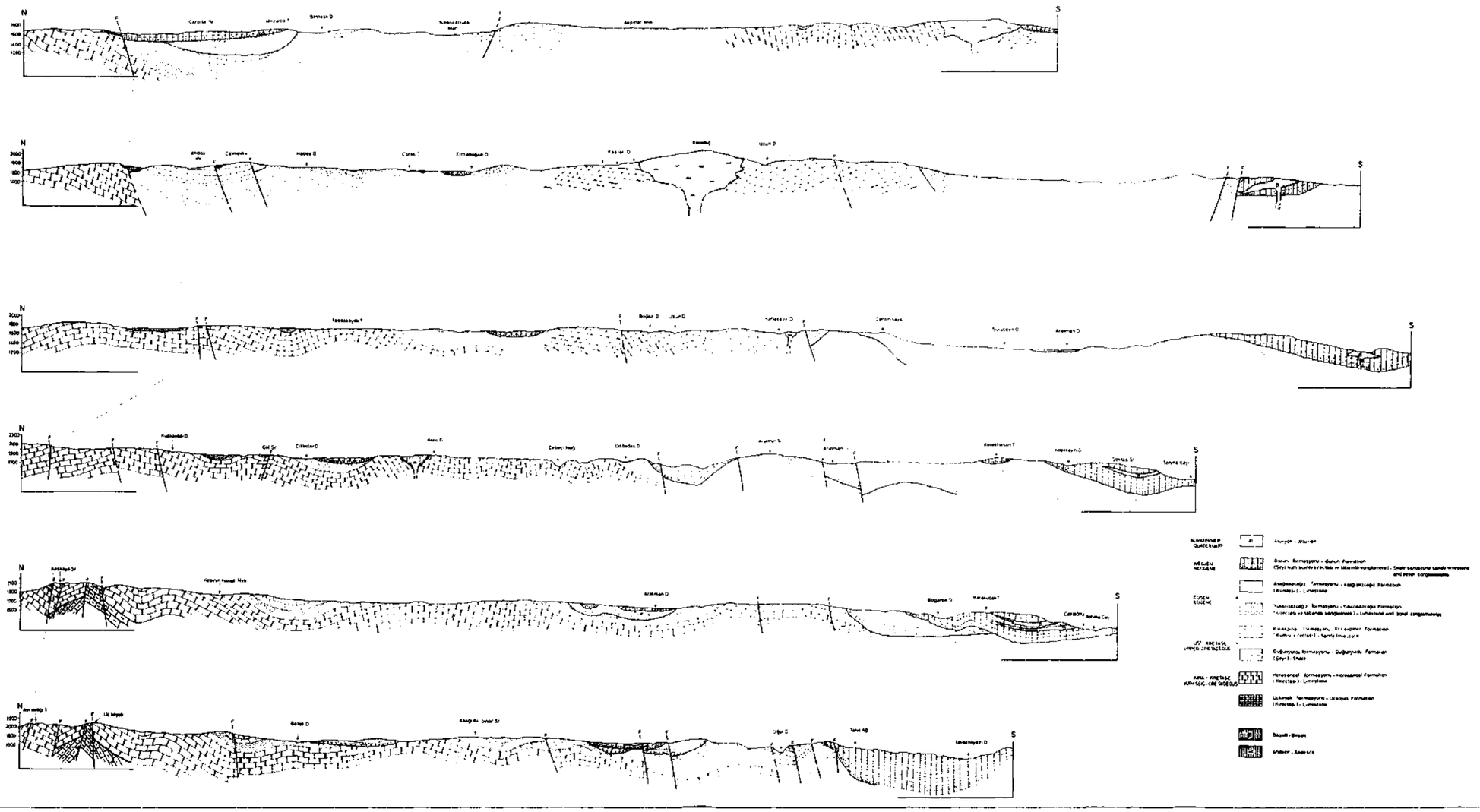
GÜRÜN BÖLGESİ JEOLOJİ HARİTASI

GEOLOGICAL MAP OF THE GÜRÜN AREA



GÜRÜN BÖLGESİNİN JEOLOJİ KESİTLERİ

GEOLOGICAL CROSS SECTION OF THE GURUN AREA



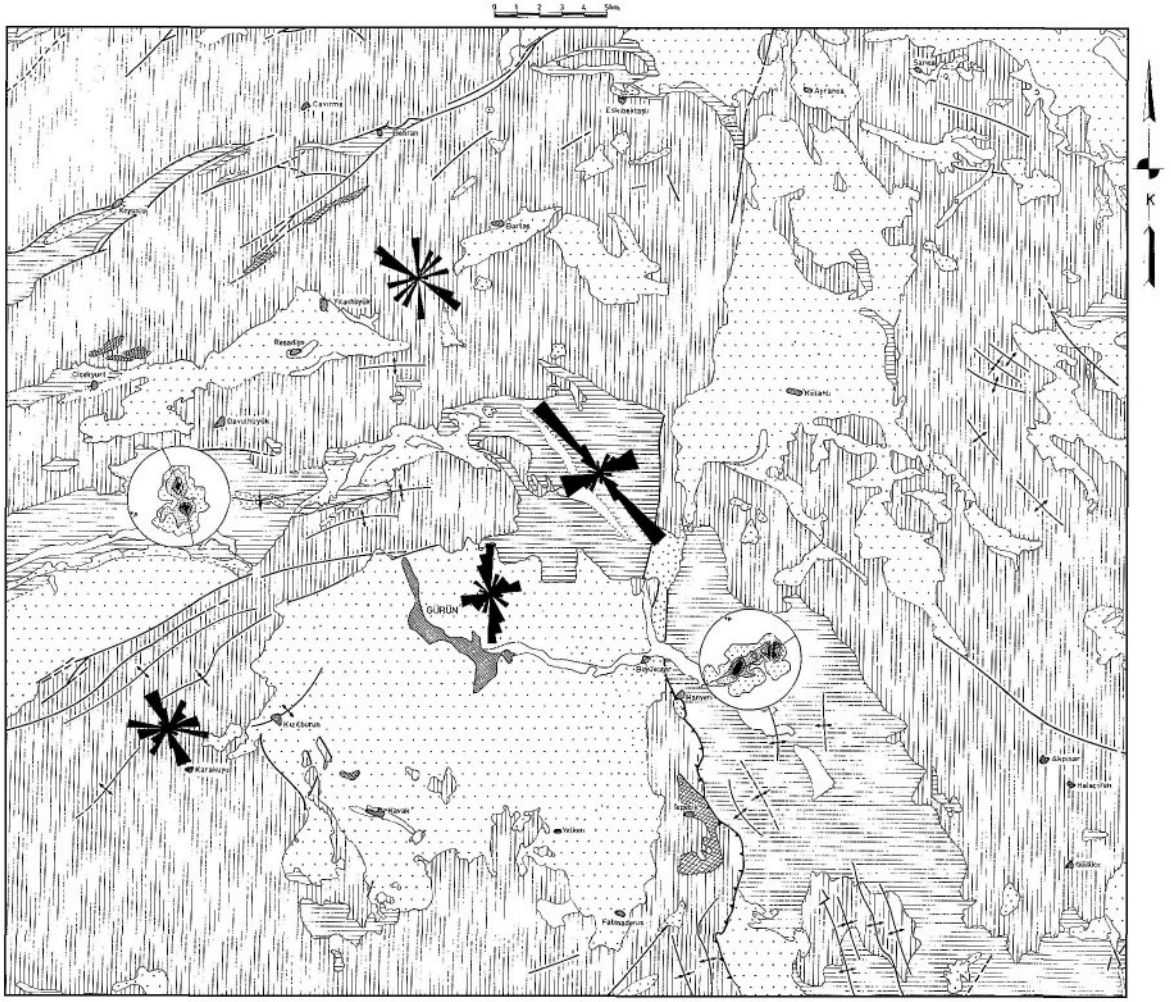
COMPOSITE STRATIGRAPHIC LOG OF THE STUDY AREA

Ekrem KILIÇMAN

ERA	SYSTEM	PERIOD	SERIES	EPOCH	FORMATION	THICKNESS	LITHOLOGY	DESCRIPTION
QUAT.								Alluvion
CENOZOIC	TERTIARY	NEOGENE						Andesite – basalt lavas and sills
					GÜRÜN FORMATION (Tna)	750 m		Basal conglomerates followed by thin-bedded lacustrine limestones, shale and marls
		PALEOGENE		EOCENE	ASAĞI SAZCAĞIZ FORMATION (Tes)	1000-1750m		Alternating gray-to-beige colored sandstone, shale, sandy limestone and marl beds
					YUKARI SAZCAĞIZ FM. (Tey)	250m		Red-to-buff colored basal conglomerates followed by light gray colored and bedded limestones containing aboundant Nummulites
MESOZOIC	CRETACEOUS		UPPER CRETACEOUS		KONAKPINAR FM. (Kük)	200-350m		Gray-to-beige colored brecciated limestones and biomicritic limestones
					DÜĞÜNYURDU FM. (Küd)	150-750m		Gray-to-beige and locally red colored marls and shales, sandstones and sandy limestones occur in the upper levels
	JURASSIC — CRETACEOUS				HORASANÇAL FORMATION (Jkr)	200-800m		Light gray, white-to-pink colored massive limestone
PALEOZOIC	Permo-Carboniferous				UCKOYAK FM. (Pük)	300m		Dark gray-to-black colored detritic limestone

GÜRÜN BÖLGESİ TEKTONİK HARİTASI

STRUCTURAL MAP OF THE GÜRÜN AREA



Hersiniyen orogenezinin etkilediği sahalar
Regions effected by Hercynian orogenic phase

Karamiyen fazının etkilediği sahalar
Regions effected by Laramian orogenic phase

Pirene fazının etkilediği sahalar
Regions effected by Pyrenean orogenic phase

Attik fazının etkilediği sahalar
Regions effected by Attican orogenic phase

Kıvrımlanmamış sahalar
Regions without folding

Eğilim diyagramı
Rose diagram

Fay
Fault

Sarkaj
Overthrust

Antiklinal
Anticline

Senklinal
Syncline

Tabakalanma ve ortalama kıvrılı eksenin yönleri Schmidt diyagramı
Schmidt diagram showing bedding and mean fold axis