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.

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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).

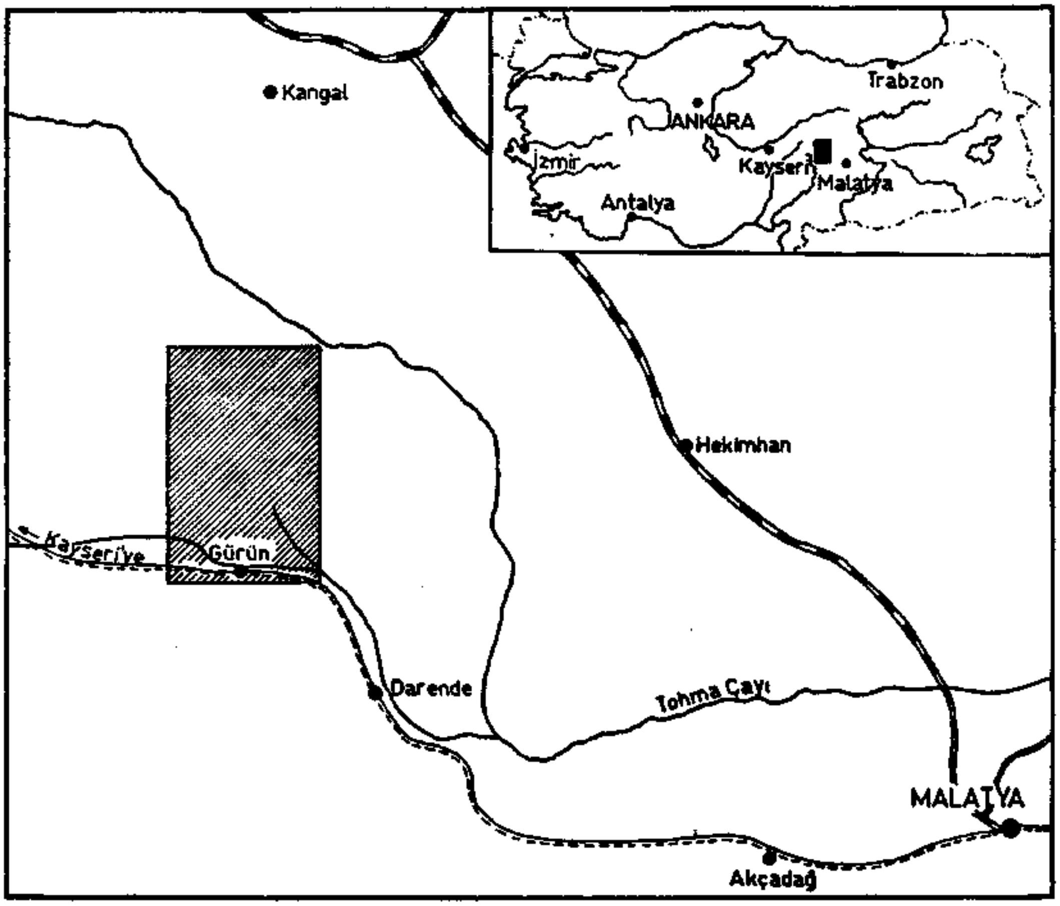

Fig. 1 - Geographical position of the survey area.

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 Cretaceous 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).

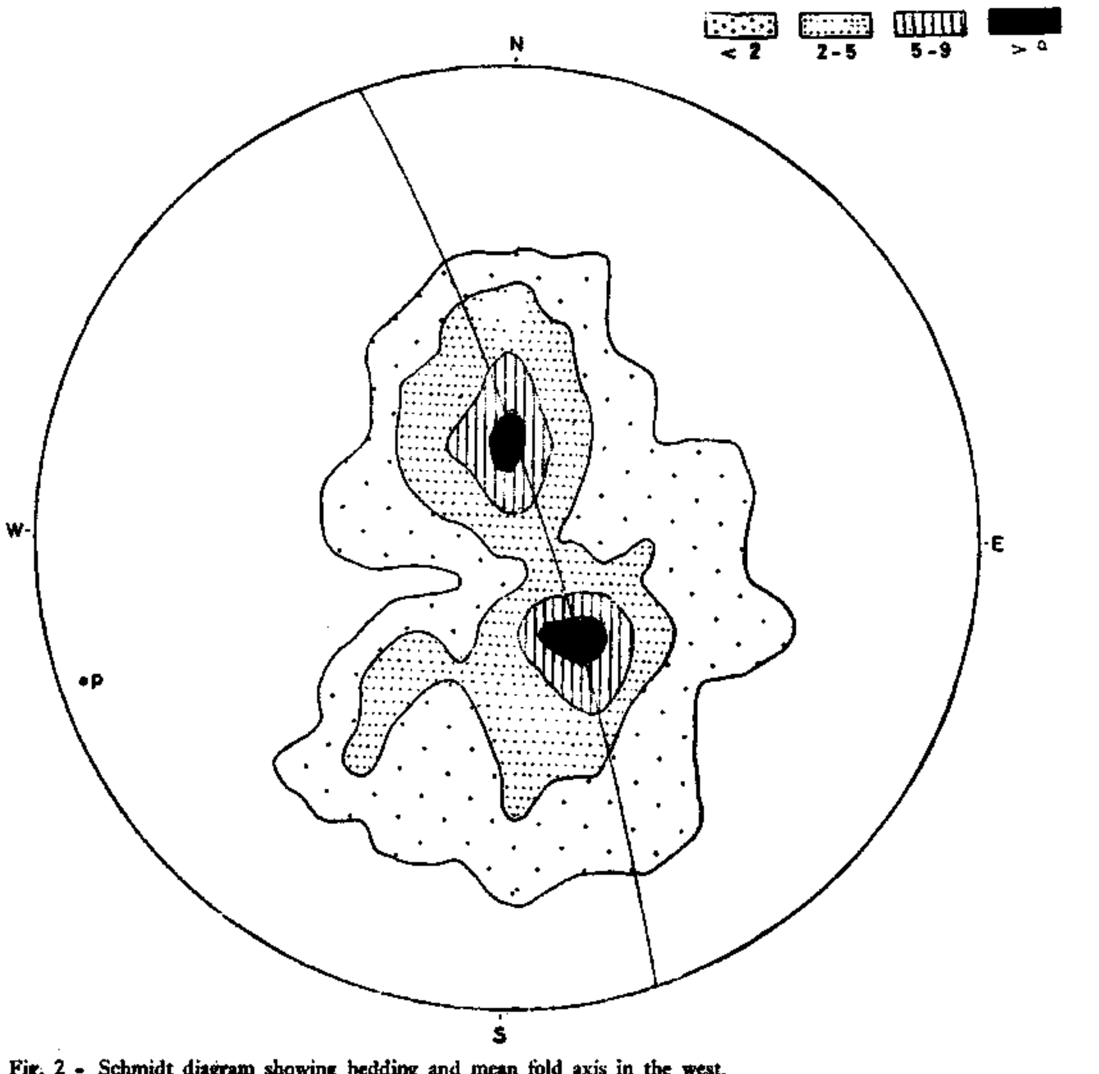

Fig. 2 - Schmidt diagram showing bedding and mean fold axis in the west. P-Fold axis. Measurements: 63.

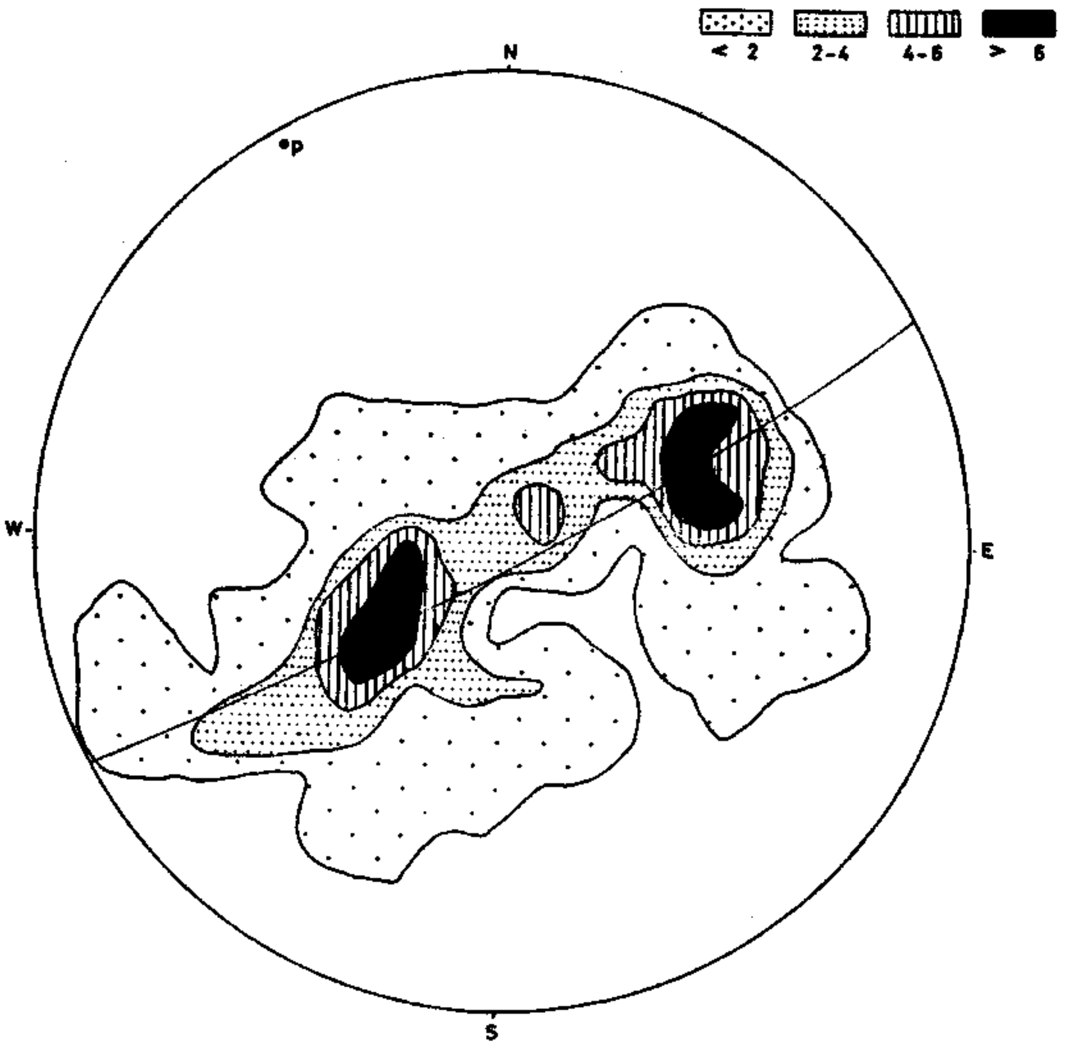

Fig. 3 - Schmidt diagram showing bedding and mean fold axis in the east.
P-Fold axis. Measurements: 62.

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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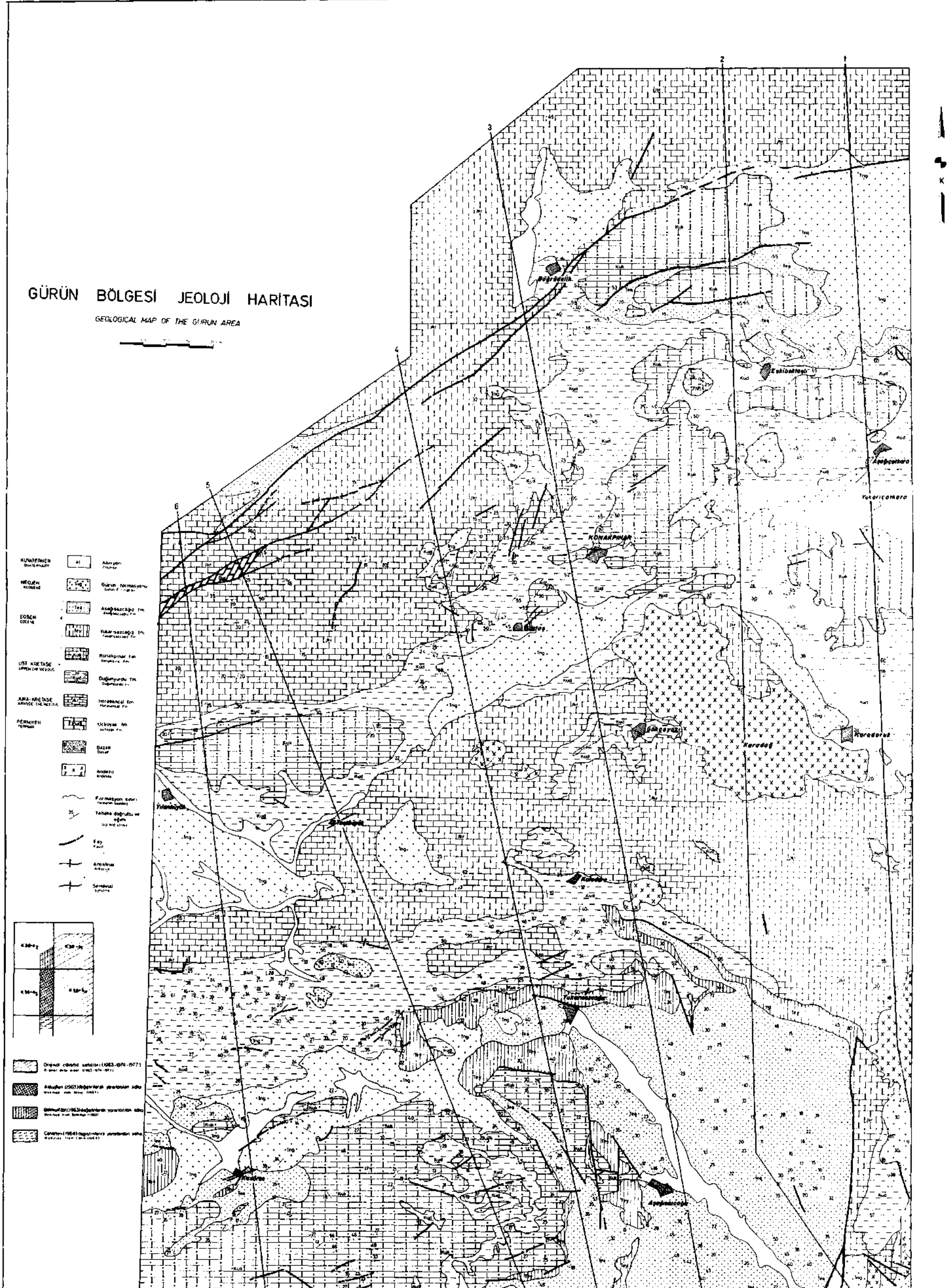
GÜRÜN BÖLGESİ JEOLOJİ HARİTASI
GEOLOGICAL MAP OF THE GÜRÜN AREA
KUVATERNER
QUATERNARY
Alüvyon
NEOJEN
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Gürün formasyonu
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Aşağısazcağız fm
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Konakpınar fm
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UPPER CRETACEOUS
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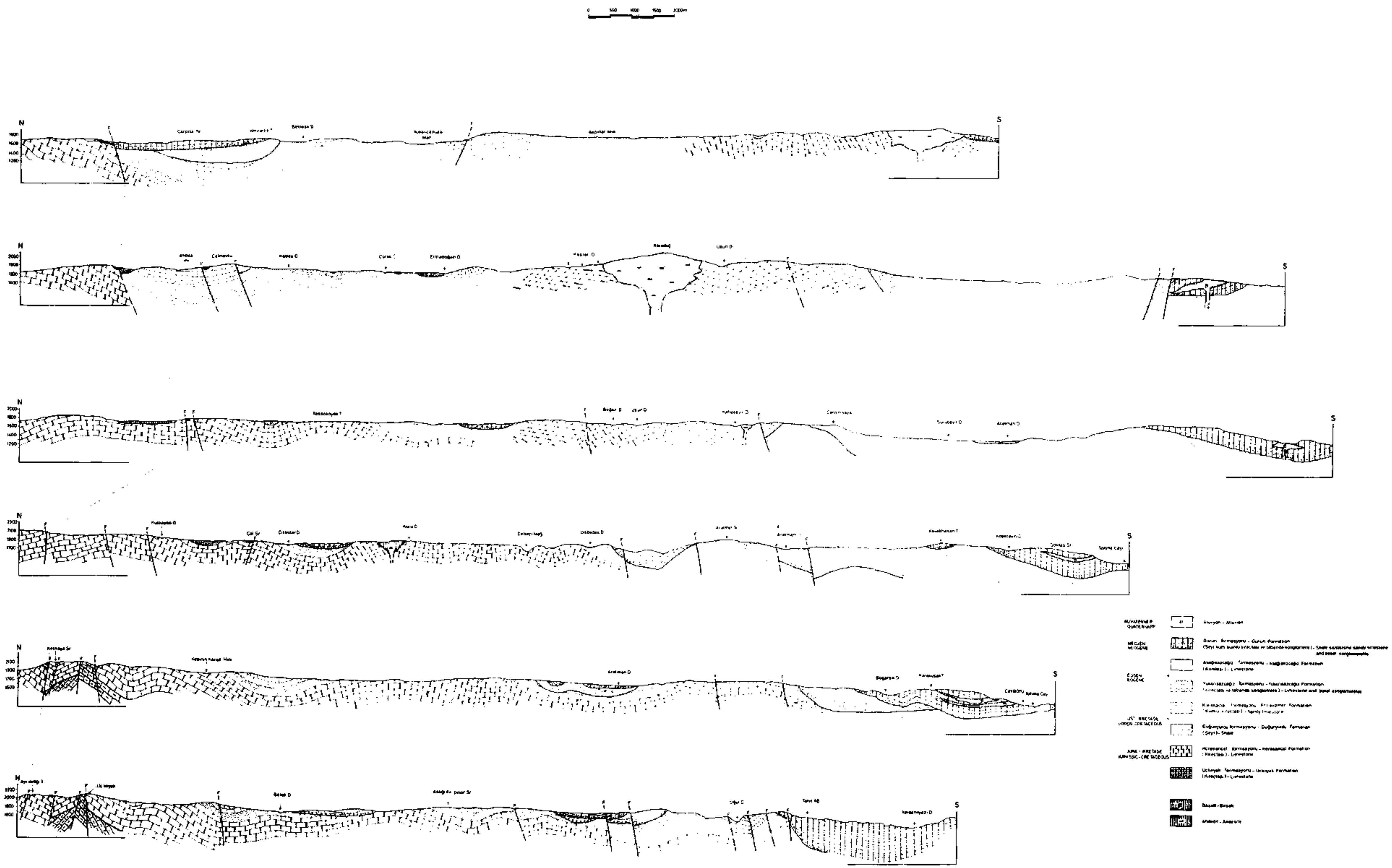
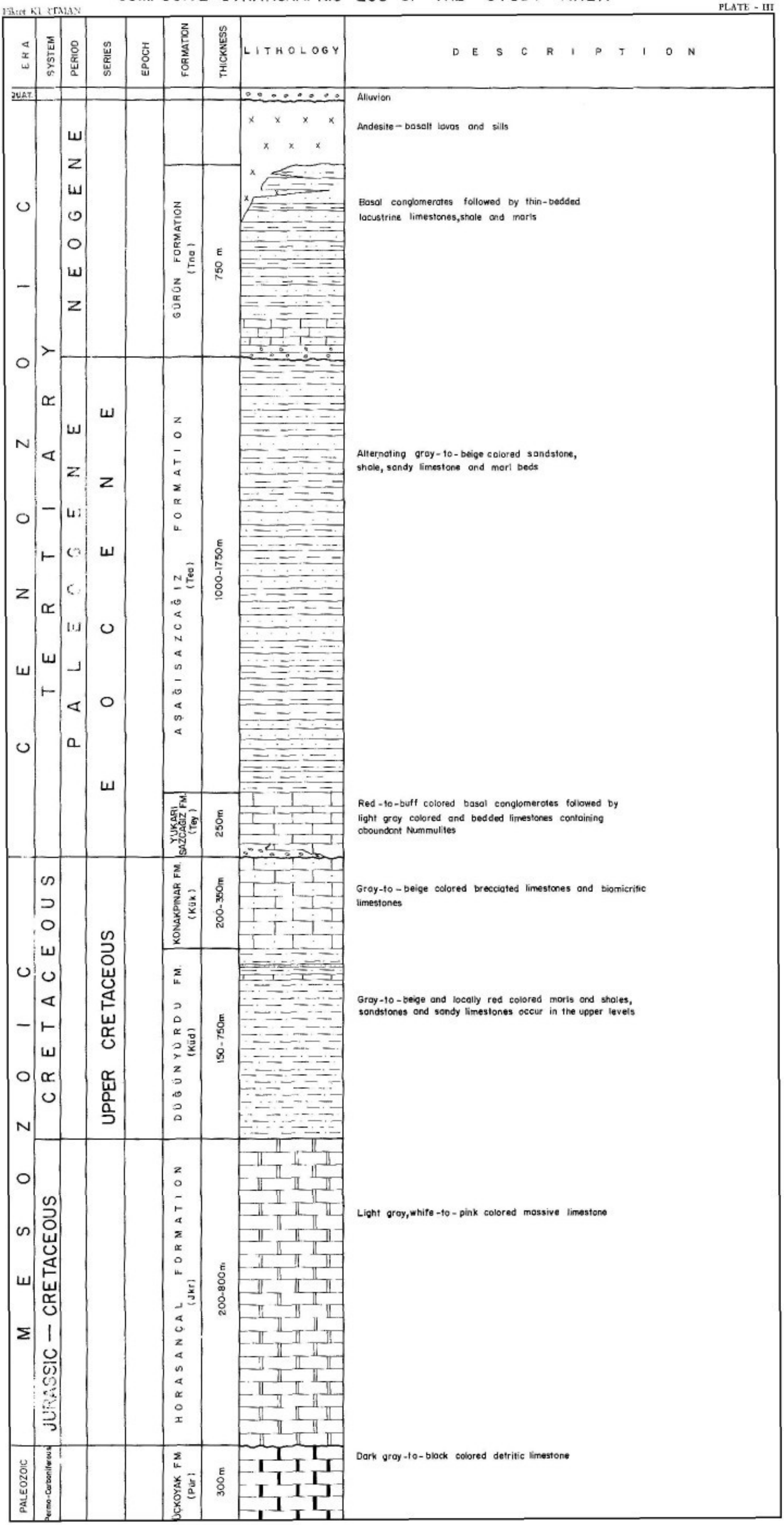
PERMIAN
Uckoyak fm
Bazalt
Basalt
Andezit
Andesite
Formasyon sınırı
Tabaka doğrultu ve eğimi
Fay
Fault
Antiklinal
Senklinal
Syncline
Boğazdelik
Eskibektaşlı
KONAKPINAR
Karadağ
Karadoruk
Yılanlıoğlu
Aşağısazcağız
Sarıyar
GÜRÜN

GÜRÜN BÖLGESİNİN JEOLOJİ KESİTLERİ

GEOLOGICAL CROSS SECTION OF THE GURUN AREA

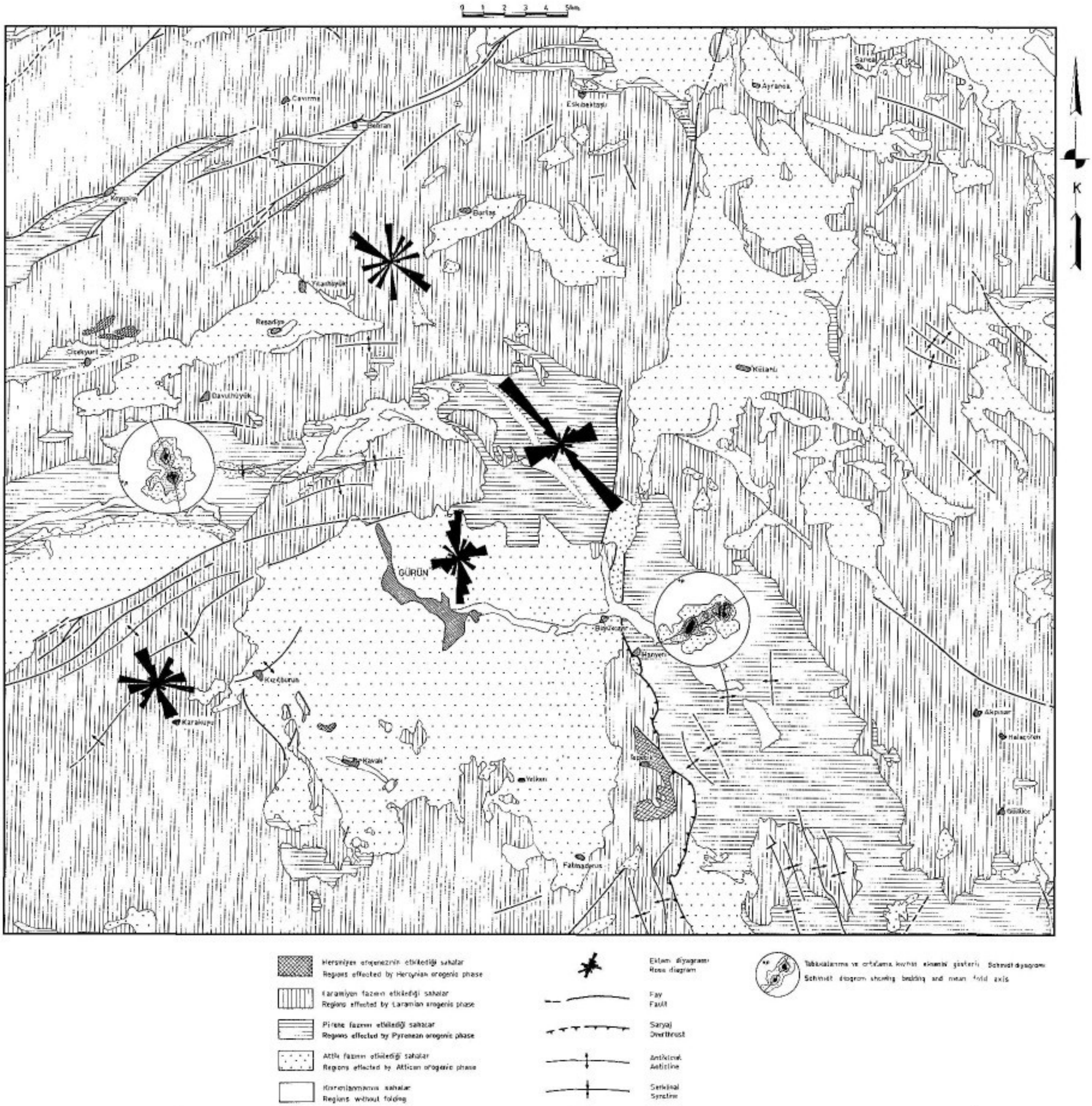


COMPOSITE STRATIGRAPHIC LOG OF THE STUDY AREA



GÜRÜN BÖLGESİ TEKTONİK HARİTASI

STRUCTURAL MAP OF THE GÜRÜN AREA



GEOLOGIC-STRUCTURAL FEATURES AND THE SULPHIDE DEPOSITS IN THE AREA WEST OF THE ŞAVŞAT (NE TURKEY)

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ABSTRACT. — The area under investigation belongs to the Pontid-Adjaro-Trialete tectonic unit. In the evolution (Upper Cretaceous-Tertiary) all formations of this geotectonic unit were formed in the eugeosynclie. These formatictos are basic-carbonatic as regards their chemical-mineralogical character with the tendency of periodic acidity, while petroiogically they are volcanic-sedimentary.

In the area of Şavşat generally have developed andesitic rock facies. The Artvin Paleozoic barrier had a significant role in separating the facies of Hopa, Artvin and of Şavşat. An important member of the volcanic-sedimentary series the amygdaloidal andesite is in form of slightly prominent and irregular brachyanticline, its longer axis striking NW-SE. All other mapped units, in general, strike ESE.

The Trialete folding phase in the Lutetian-Priabonian interval encompassed all parts of the Pontid-Adjaro-Trialete geosyncline. The fault tectonics is very much pronounced with three fault systems.

The majority of fault structures served as suitable routes for hydrothermal solutions which led to intensive pyritization and sulphide polymetallic (Cu, Zn, Pb) mineralization. Some of these fault structures were reactivated in the Tertiary and new ones created with andesites, diabases and basalts injected alongwith.

INTRODUCTION

The geological investigations in the course of summer 1972 were carried out in the region of Dereiçi NNW of Şavşat (NE Turkey) by a Turkish-Yugoslav team of geologists: Mustafa Demirkan, Dragan Koprivica, Djordje Klajn, Dr. Tiosav. Novovic, Desimir Puric, and Vladimir Stevanovic. This time, 40 sq. km were explored and mapped in the scale of 1:10,000 and sulphide ore occurrences were treated separately. This author has interpreted field and laboratory data giving their synthesis in this paper (Koprivica *et al.,* 1973). Due to the small scale of the geological map, pyritization, silicification and argillization are not shown. Other informations from the original map are contained in the geological one.

Laboratory analyses were carried out in the laboratories of the M.T.A. Institute. Petrographic samples were determined by Dragan Pesic and Jane Jancevski. Microscopic analysis of ores were done by Dr. Güner Aslaner and Dusan Kleut. Geochemical analysis by Vasa Ocokolic and chemical ones by Ekrem Ceyhun. Micropaleontobgical fossil fauna were determined by Ibrahim Çakmak and Fahrettin Armağan. DTA analyses by Sami Can.

The existing geological knowledge of the investigated area is insignificant. According to the data of K. Etay, Turks mined ores as early as in 1870 at the locality of Madenköy. The investigated area is shown on the geological map of Turkey sheet Kars 1:500,000. It is worth mentioning that the new investigations of Soviet geologists on the Minor Caucasus offer better insight into geological, stfuctural and facial characteristics Which pass to the Black Sea region of the NE Turkey. The investigated area belongs to the geotectonic unir of the Adjaro-Trialete zone (Mağaklyan, 1960; Dzocenidze & Tvalcrelidze, 1968; Pejatovic, 1971). In 1972- 1973, a large number of ore occurrences were insvestigated and some mining was started by the BAMAŞ company of Ankara.

LITHOSTRATIGRAPHIC CHARACTERISTICS

This ground is formed of volcanic-sedimentary, volcanic and sub-volcanic-intrusive rocks of the Senonian to Quaternary ages. The description includes the whole range of formations from the oldest to the youngest ones.

Andesitic breccias

This member is identified in lower section of Çukur D. Andesitic breccia is the oldest member in the investigated area. They are volcanic-sedimentary. Some parts look like pyroclastic breccias with angular fragments. [Inserted andesitic lumps varies from 2 to 10 cm^3 and rarely are in blocks over 0.5 m^3 in size. There exist rare flowing areas dipping 10° to 20°. Fresh parts are grey.

The texture of andesitic breccias is lithoclastic and crystallo-lithoclastic. The rock is formed of angular fragments of andesites and angular grains of plagioclases. Altered Fe-Mg minerals are rare. The cement consists of tuff—argillitized—chlorite mass with pronounced oolitic texture. The accessory minerals are magnetite converting into martite, while pyrite and chalcopyrite are rare.

Tuffaceous sandstone, andesitic microbreccia, limestone and diabase

This member is gradually transiting into andesitic breccia at both sides of the Çukur D. west from the mine of Hasan'ın Açması, tuffaceous sandstones and limestones underlie amygdaloidal andesites and breccia. In the eastern and southeastern part of the investigated area (Çağlayan D. and Meydancık Ç.) andesitic microbreccias, tuffaceous sandstones and limestones overlie amygdaloidal andesite. Such relationship may be explained by the fact that this member was formed before and during the extrusion of amygdaloidal andesites and that volcanic-sediments continued to be deposited over the amygdaloidal andesites.

The member described is volcanic-sedimentary in origin and is consisting of andesitic microbreccias, tuffaceous sandstones and limestones and in a lesser degree of diabases. The often pronounced stratification strikes south-east, rarely east and north-east. The dip angle varies between 12° and 35°, is rarely steeper and horizontal layers are noticed locally. Rythmical alternative of amygdaloidal andesites, tuffaceous andesitic breccias and tuffaceous sandstones are also noticed in the area.

Andesitic microbreccias are silicified, argillitized and calcitized. The texture is lithoclastic and crystalloclastic. The rock is formed of fragments of andesites and plagioclase. The cement mass is calcitic with pronounced silification.

Tuffaceous sandstones often alternate with carbonate, sandstones and sandy limestones. The structure is microbrecciated, lithoclastic and medium grained. The rock is formed of angular and subangular grains of plagioclase and fragments of andesites and tuffs. Cement mass is tuffaceous, argillitized, chloritized and calcitized.

In the andesitic microbreccias and tuffaceous sandstones a large number of faults were identified with pronounced pyritization and silification. These faults are often accompanied by sulphide mineralization (Cu, Zn, Pb).

Numerous micropaleontological analyses of limestone strata have shown the presence of microfauna at the localities of Kopek D. and north of Şarapul M. The following species and genera have been identified: *Globotruncana lapp. coronata, Globotruncana tricarinata, Globotrnncana* cf. *concavata, Globotruncana lapparenti, Globotruncana* cf. *area, Globotruncana* cf. *calcarata, Globotruncana area, Globotruncana linneiana, Globotruncana* cf. *linneiana, Globotruncana* sp., *Gümbelina* sp., Radiolaria, Textularidae. According to the microfauna classification and the superposition of geological members, this member corresponds by age to the Middle Senonian (Santonian-Campanian) and though the presence of *Globotruncana concavata* leads us to the Santonian.

Diabases occur in form of interstratified flows which are like tuff-carbonate sandstones. These diabases are characterized by the absence of shortage of augites contrary to the Tertiary effusions and penetrations. Accessory minerals are magnetite which is coverted into martite, with pyrite, chalcopyrites and bornite in traces. North of the mouth of the river Çukur D. (on the roadcut) there is an old tunnel in diabases which follows the fault striking 325°. In the tectonic diabase breccia there are pyrite, chalcopyrite and azurite, with intensive silification.

Amygdaloidal andesite and breccias

This member forms the central part of the investigated area. It strikes NW-SE and stretches along about 4 km with the average width beeing 1.5 km. Amygdaloidal andesites often alternate with andesitic breccias. Younger parts have porphyric and amygdaloidal texture. Megascopic investigation reveals feldspar crystals are visible and colourful constituents are chloritized, sericitized and limonitized. Their colour varies from grey-yellow to white (depending on the degree of dissintegration). Amygdaloidal andesites and breccias are intensively hydrothermally altered and pyritized (Photo 1). Andesite is very much argillitized (illite or montmorillonite), silicified, chloritized and calcitized, partly sericitized and albitized. Pyritization is most pronounced along faults.

The andesite texfure is porphyric, rarely combined holocrystalline porphyric, amygdaloidal and fluidal. Phenocrystals are made of plagioclases (andesine-oligoclase). Fe-Mg minerals are most frequently chloritized. The groundmass contains fine grains of plagioclases and fluidal oriented glassy compounds. As accessory minerals it contains pyrite, chalcopyrite, sphalerite, rarely rutil and magnetite. Two phases of pyritization may be identified: the first phase is synchronous with andesite formation (syngenetic) and the second phase is parallel to the sulphide mineralizations (Cu, Zn, Pb). The primary phase of pyrite is confirmed by numerous ore-microscopic analyses which identify pyrite as an accessory mineral in andesite. Amygdaloidal andesites and breccias are important members of the investigated ground as they contain the maximum number of sulphide ore veins some of them being those which were mined in 1972-1973 exclusively lie in them. An interesting piece of information is conspicuous, namely that the routes of effusive areas of these andesites strike south-west at the dip angle of about 35° (at the Binektaşı mine) which means a deviation from the strike of all other members of the area investigated.

Andesite

This andesite is distinguished in the region of Şarapul M. - Kurdiçvan M. By its specific appearance it differs from other rocks being very bleached and silicified with phenocrystals of bleached feldspars. It overlies tuffaceous sandstones and andesitic breccias. In some parts it is characterized by heavily pronounced prismatic effusion (Fig. 2).

The andesite texture is porphyric. It is intensely argilized, silicified, and limonitized, rarely calcitized, albitized and chloritized. Phenocrystals are plagioclase and rarely potassium feldspar.

The groundmass consists of fine plagioclase grains and it is partly with pronounced fluidal texture. Fe-Mg minerals are totally altered.

North of Şarapul M., and along the faults there are minerals of Pb, Zn, Cu in argilized, pyritized and silicified andesites.

Stratified andesitic breccias and tuffs

These rocks form the northwest portion of the area investigated (Tepebaşı-Akkavak-Biiyiik9ukur) and the area southeast of the Dereiçi M. They are formed of andesitic and tuffaceous breccias with andesite intercalations. They alternate with small layers of tuff sandstones and carbonate sandstones while sandy limestones are noticed rarely. The texture is breccoid and lithoclastic. Colours are grey and often bright yellow (limonitized parts). Andesitic tuff breccias combined with microbreccias are intensely silicified and argillized. Slightly pronounced is the stratification, striking east, rarely north-east and south-east. The dip angle varies between 10° and 40°.

The structure of stratified andesitic breccias is crystallo-lithoclastic and lithoclastic. The rock is composed of angular andesitic fragments, plagioclase grains and altered Fe-Mg minerals. The cement mass is tuffaceous. Minor parts of andesite with porphyric and amygdaloidal texture are encountered in these breccias.

Tuffaceous sandstones and clayey tuffs are chloritized calcitized, silicified and carbonatized. Their textures are crystallo—lithoclastic and fine—grained. Brecciation and silicification is pronounced along the faults which are also accompanied by pyritization and sulphide mineralization of Pb, rarely Zn and Cu (Fig. 1).

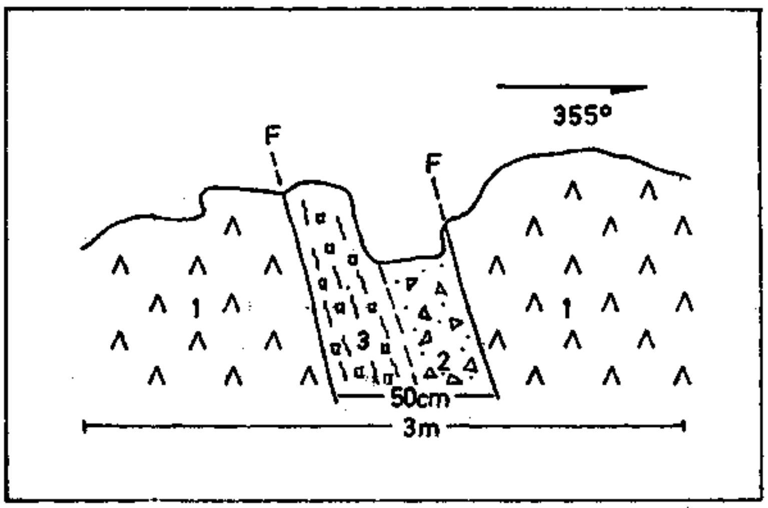


Fig. 1 - Profile southward of Tepebaşı. 1 - Andesitic breccias; 2 - Brecciated and argilized zone; 3 - Silicified and mineralized zone.

In the upper parts of tuffaceous sandstones there are limestone lenses like shoals which contain sections and fragments of rudist fauna. The following forms of microfauna are determined in limestones: *Lepidorbitoides* sp., *Siderolites* sp., *Textulariella* sp. and Rotalidae. According to the superposition of members and scanty fauna, this member probably corresponds to the Maestrichtian substage. Stratified andesitic breccias and tuffs very likely represent an extent of the amygdaloldal-andesite extrusions in forms of pyroclastic fades.

Rhyodacite and dacite

These rocks spread over a small area of the area investigated south from Akkavak M. They occur as breaches of minor bodies, sills and veins. They are penetrating into tuffeceous sandstones and stratified andesitic breccias and tuffs. The macroscopic observations show that both dacite and rhyodacite have porphyric and hyaline texture. Feldspar and quartz may be noticed in it. Colours are white and yellow, rarely light grey.

Rhyodacite and dacite are porphyric and holocrystalline in texture. Phenocrystals are plagioclase, grains of corroded quartz and rarely K-feldspar. Fe-Mg minerals are totally altered. The groundmass is consisting of quartz grains, plagioclase and K-feldspar. Rocks are as a rule intensely silicified, argilized, sericitized, less limonitized, chloritized and calcitized. The accessory mineral is metallic. The age of rhyodacite and dacire according to their composition, rock habitus and locations falls into the younger stage of rhyodacite and dacite near Hopa (Koprivica, 1971, 1977) and Artvin (Koprivica, 1973a).

Limestone

Limestone have been identified over a small area in the southwest part of the geological map but they spread much more outside the area investigated. They are formed of clastic materials and macrofauna fragments, are not pure and contain plenty of tuff materials. They are stratified in banks and strike WSW at the dip angle of 23°. Steep ridges of 10 to 30 m are strongly marked along a fault striking NNE-SSE. The limestones contain the following microfauna species: Rotalidae and Algae. By age they most likely belong to the Maestrichtian.

Hornblende biotite dacite

This dacite is identified in the profile of the Çağlayan D. Large masses of dacite are impressed in form of sills and bresches (Photo 3) into tuffaceous sandstone and andesitic microbreccias.

The megascopic observation shows that the rock has dense habitus and lath texture. Crystals of feldspar and horblende are evident while quartz is less noticeable. Prismatic effusion with large number of fissures is the characteristic feature. They often fall off steep slopes and form thick deposits of rock debris.

Hornblende biotite dacite is albitized, chloritized and slightly silicified. Its structure is holocrystalline porphyric and porphyric. Phenocrystals are plagioclase (oligoclase-andesine) and less quartz with corroded edges. Coloured constituents are hornblende and biotite. The groundmass is composed of fine grained alkaline feldspar, quartz, amphibole and biotite scales. Accessory minerals are spatite and metalic one. As regards mineralization this dacite is fully sterile. We have no precise data on its age. According to Azizbekov *et al.* (1970), Paleocene volcanism with thin dacites occurred at the periphery of the Adjaro-Trialete zone at the boundary to the Artvin-Bolnic median massive. Therefore this dacite could be of the same age.

Hornblende andesit

These andesites form the central part of the area investigated. Hornblende andesite is characterized by porphyric structure with phenocrystals of feldspar and hornblende. It is often fresh but'there are parts which are altered and broke into balls. It may be assumed that the formation of hornblende andesite was multi-staged. In fresher parts there are coloured ingredients which form predominating ridges on the ground (Photo 4).

They contain abundant hornblende crystals, the length of which reach 2, cm and the width 0.5 cm. There are parts which contain over 50 % coloured constituents (predominantly hornblende). Colours are dark grey. Field investigation confirms intensive hydrothermal alterations of hornblende andesites. These alterations are most noticeable at the right bank of the Hanezori D., i. e. along the contact of amygdaloidal andesite and breccia. Hydrothermal changes are manifested by intensive argilization, silicification and pyritisation with minor occurrences of Cu and Pb.

The hornblende andesite texture is holocrystalline porphyric and porphyric. Phenocrystals are plagioclase (andesine-oligoclase). Fe-Mg mineral is hornblende, rarely also biotite and augite. Accessory minerals are metallic ones and apatite. On the basis of numerous petrographic analysis (D. Pesic) the acid tendence was identified in these hornblende andesites, i. e. some petrographic analyses have pointed to minor occurrence of hornblende dacite. This dacite has the same petrological properties as hornblende andesite except for the presence of inconsiderable quantities of quartz for which they can be taken as andesites with some quartz.

Hornblende andesite is later than the sulphide occurrences in the investigated area. Sufficient proof of this is intersected ore body of Kaya'nın madeni containing hornblende andesite.

Diorite

Minor differentiates of hornblende-augite diorite were identified in hornblende andesite together with some biotite diorite and quartz diorite. These intrusions have petrological properties comparable with volcanic rocks with which they are associated in the Black Sea region.

There are proofs of such occurrences in the Caucasus Minor published by Dzocenidze and Tvacrelidze (1968): «Intrusive gabbro, diorite-sienite and plagiogranite have petrological properties which correspond to volcanic rocks that they mix with and these intrusions behave as product of basalt magma in all respects». It is difficult to distinguish these varieties of hornblende andesite in the field and for this reason we have drawn our boundary as gradually transiting over from diorites into hornblende andesite. Such intimacy of diorite and hornblende andesite points to sub - volcanic level ot hardening and crystallization in the hybride rocks of the same magma.

The texture of diorite is coarse — grained and idiomorphic — grained. The rock consists of plagioclase grains (mostly of andesine, rarely albite and oligoclase). Fe-Mg minerals are biotite, augite grains and hornblende prisma. Interior spaces are filled with chlorite, secondary quartz and caleite. Accessory minerals are magnetite, pyrite, martite, rarely ilmenite, rutil, epidote and apatite. Also identified are the differentiates of gabbro—diabase and gabbro—diorite with grain and ophitic structure.

Compared to similar intrusions on the Caucausus Minor these intrusions may be considered to have been formed in the period between Middle Eocene and end of the Oligocene.

Final volcanic rocks

Andesite-basalts, diabases and basalts occur in the investigated area in form of minor bodies, veins and sills. The way of their occurrence and their relationship with surrounding rocks is characteristic in the Black Sea region while further towards the Caucasus Minor and the Anatolian plateau there are spacious and thick effusions.

Andesite-basalt. — Is identified in the region of Dereiçi M. and in form of a sill east of Tepebaşı. They are not easily distinguished from basalt. They look fresh in dark grey-green colour and with hyaline (fluidal) texture. Andesite basalts contain augite and hornblende. Their texture is porphyric, rarely holocrystalline porphyric. Phenocrystals are plagioclase (labradorite and andesine). The groundmass is ophitic and granular consisting of plagioclase and rarely augite. Accessory minerals are magnetite, pyrite and chalcopyrite. Microscopic the rock show the properties of chloritization, argilization, silicification and calcitization.

Augite-diabase. — Is manifested in form of minor and larger veins and sills over the whole mapped ground. The most characteristic ones are two veins like walls between the villages of Gigezeler M. and Dereiçi M. (Photo 5).

The veins of augite-diabase strike NW - SE. Their thickness varies from 2 to 10 m. They are altered but over the surface only. Their colour is dark-green to grey olive. The diabases as a rule contain augite. Their texture is ophitic and rarely combined with porphyric, fluidal and amygdaloidal ones. The rock consists of plagioclases, most frequently labradorite, rarely albite. Interstities are filled with chlorite, rarely with secondary quartz and calcite. Accessory minerals are magnetite, rarely chalcopyrite and very rarely pyrite and martite. Frequent and pronounced alterations are chlorization, calcitization, argilization and silicification. The albitization has rarely been seen.

Augite-basalt. — Occurs in form of minor veins, rarely sills in all formations at the mapped area. They generally strike SW - NE. When broken, they show fresh and dark green colours. As a rule, basalt contains augite and less olivine. Their texture is porphyric and holocrystalline porphyric. Phenocrystals are plagioclases (labradorite, less bitovnite). Augite is found in crystals and grains while olivine is serpentinized. The groundmass consists of plagioclases ophitic in texture. Interstities are filled with quartz, metallic mineral, rarely calcite, chlorite and olivine. The accessory minerals are magnetite, pyrite and chalcopyrite. In addition to their fresh appearance augite-basalts are partly silicified, calcitised and chloritised.

Alluvium

Alluvial formations lie only along the Meydancık O. profile in river windings and expanded parts of the river bed. There are deposits of naturally granulated sand and gravel fractions. They are formed of quartz and volcanic sedimentary rocks. Sand and gravel serve as input materials in the manufacture of building materials.

TECTONICS AND MAGMATISM

The investigated area belongs to the Pontid-Adjaro-Trialete geotectonic unit. According to numerous studies by Soviet geologists of recent dates: Magaklyan (1960), Dzocenidze & Tvalcrelidze (1968), Zaridze (1968) and others the geoteclonic units on the Caucasus Minor have been classified and they continue without interruption westwards. Therefore the Adjaro-Trialete system passes over into the Pontid geotectonic unit whose westward extension sinks under the Black Sea Adjaro-Trialete zone.

During its evolution in the Alpian cycle (Cretaceous-Tertiary) this unit had typical eugeosynclinal character. The chemical and mineralogical character of the formations in this geosynclinal zone is basic carbonate with periodical acidity while petrological properties are volcanic and sedimentary.

In the southern part of the Pontid-Adjaro-Trialete zone volcanic-sedimentary-carbonate formations were formed during the Seoonian (before folding). During folding throughout the Laramian phase (Upper Senonian-Eocene) the flysch-like sediments were formed such as carbonate and clays and marls (Hopa-Borçka-Artvin, by Koprivica *et al.,* 1971 and 1973a). The

Trialete folding stage in the Lutetian-Priabonian encompassed all parts of this geosyncline (Gamkrelidze, 1949; Zaridze, 1968), and is fixed by large scale sea regression and the end of volcanic activity. This geotectonic unit in the course of the Alpirle cycle was completed in full by Miocene.

Some lithological difference may be noticed between the Upper Cretaceous, formations in the Hopa-Murgul and Artvin areas on one side and Şavşat on the other. In the coastal Black Sea part and in the regions of Murgul and Artvin, the lower dacite series is almost, as a rule, underlying the basic volcanic-sedimentary series while in the region of Şavşat we have andesitic rock facies which correspond to the same interval. An important role in the facies separation was by all means played by the Artvin barriere (a dekyed anticline, made of Paleozoic granites and schists).

The volcanic-sedimentary complex starts with andesitic breccias in the, mapped area. These breccias alternate with tuffaceous sands and andesitic microbreccias with syngenetic diabase effusions. The amygdaloidal andesite and breccia extrusion occurred simultaneously with the formation of tuffaceous sandstones and microbreccias. All volcanic-sedimentary members are accompained by some limestone with microfauna which points to short intervals of peaceful volcanic activity. Dacite and rhyodacite are manifested in a minor area and probably correspond to young rhyodacite at Hopa and Artvin. The hornblende facies of andesite developes over the larger part of the area in form of breaches and effusions. Minor occurrences of diorite differentiates represent the intrusions formed in sub-volcanic levels and originated from the same magma.

All members of the volcanic-sedimentary formation of the mapped area generally strike east; namely at the south they strike E-SE and at the north E-NE. In the area of Çukur dere-Tepebaşı gentle folding is evident as shown on the E-W geological cross section. Amygdaloidal andesite and hornblende andesite are discovered in the apex of an irregular brachy-anticlinal formation striking along the NW-SE axis.

Faults are very prominent and mostly two fault systems predominate. The first system strikes NW-SE and the other NE-SW, The faults striking NE are less prominent. The NW - SE fault system is longitudinal i.e. its strike coincides with the strike of geological members. The majority of sulphide ore NW-SE striked: Binektaşı, Fikri'nin madeni, Kaya'nın madeni, Hasan'ın açması, Yeni açması. The faults striking NE-SW and N-S are accompained by intense pyritization with rare polymetallic mineralization. The majority of fault structures serve as favourable routes for hydrothermal solutions of sulphide polymetallic mineralization. The whole process is accompanied by intense silicification and argilization. The predominant hydrothermal processes were developed in form the amygdaloidal andesites and breccias.

Most fault structures were reactivated in the post ore period (Eocene - Quaternary) with members of final volcanism (andesites, diabases and basalts).

Between Miocene and Quaternary the phenomenon of general rising of the Caucasus Minor which was mostly reflected in the regions of geoanticline is known. According to Aslanyan (1958) this rising reached 2 to 3.5 km. This refers to the surrounding region of the mapped area with the paleogenetic sediments lying at the altitudes of over 2,000 and 2,500 m.

SULPHIDE MINERAL DEPOSITS

Ore and mineral occurrences lie in the very altered zone of amygdaloidal andesite, breccias and tuffs. The altered zone strikes NW-SE (Akkavak Y. - Dereiçi M.), in the length of 6 km over the investigated area and the average width is about 2 km. Outside the investigated area, towards northwest this zone passes into ore occurrences of the Üzümlü Y. and Madenköy.

In this zone a large number of sulphide veins of copper, lead and zinc were identified. The investigations of the BAMAŞ company of Ankara coincided with our investigations (1972-1973) and they also mined rich ore veins in the localities of Binektaşı, Talat'ın madeni, Fikri'nin madeni, Hasan'ın açması, Yeni açması and Kaya'nın madeni. In addition to the above mentioned ore deposits we discovered a large number of ore occurrences of which the more important ones are described in this chapter. According to Sopko (1971) these deposits fall into the group of vein polymetallic deposits of the Adjaro-Trialete zone.

On the basis of geological way of occurrences and mineralogical composition in this zone there are three distinct types of sulphide mineralizations and ore deposits.

I. Complex sulphide ore and mineral deposits

II. Chalcopyrite-pyrite ore and mineral occurrences in the tectonic andesite breccias.

III. Quartz veins with chalcopyrite and pyrite.

Type I

The first type occurs in form of veins in intensively argilized andesite and breccias. Ore veins differ in thickness (from several cm to 3.5 m). These veins often thicken and thin out i.e. occur in lenticles. The main ore vein often branches into several thin veins which again converge into one vein along the fault. The veins of this type are characterized by relatively high metal content. This type of ore deposits is found at the localities of Talat'ın madeni - Binektaşı - Fikri'nin madeni.

1. *Binektaşı ore occurrence.* — Is the typical representative of complex sulphide type mineralization (Cu, Zn, Pb). This vein was discovered on the erosive surface and could be traced along about 130 m. Its thickness varies from several cm to 3 m. It strikes NW - SE dipping towards SW at an angle of 45° - 50° and at some places even 80°. Three runnels were made for investigation and use of this vein.

In the uppermost horizon (922.53 m) the ore is rather broken and occurs in rich veins which fill cracks and fissures in andesite inside the fault zone. The average metal content at this horizon assays: Cu 1.43 %, Zn 5.21 %, Pb 0.73 % while the mean thickness of the vein is 0.64 m. In the middle horizon (905.00 m) the vein is compact and the metal content is relatively high (no sample was taken due to flood). In the lowest horizon (880.27 m) the vein is distinct but due to the large quartz content the metal percentage is low and the chemical content is: Cu 0.81 %, Zn 3.24 %, Pb 0.55 %. In this horizon the length of economically worth vein is smaller than in the preceding one. This clearly shows that the largeness of ore vein and the metal content diminish at the depth. This was confirmed by a borehole drilled deeper than this horizon, which gave negative results.

2. Fikri'nin madeni ore occurrence. — Strikes NW-SE along the fault. The length of the ore vein at the surface is about 200 m. The thickness varies reaching 2.5 m max. and the average thickness is about 0.70 m. It dips towards SW at angle of 50-70°. To explore this ore vein the investor prepared seven tunnels. The uppermost one lies at the level of 1106.30 m and the bottommost at the level of 1024.85 m (Photo 6).

The mining shows that the vein thins out. By its mineral composition this vein is similar to the Binektaşı ore vein. It contains high metal percentage. Minerals occurring are sphalerite, chalcopyrite, galena and pyrite. The associates are quartz and carbonates.

3. Muzo ocağı ore occurrence. — Lies about 200 m west of the Fikri'nin madeni. The ore vein strikes NW-SE dipping towards SW at an angle of 65°. The vein is lenticular interrupted and can be traced more than 50 m. It was explored with two tunnels, differing in altitude by 25 m. The vein contains rich and complex ore with dominating sphalerite followed by chalcopyrite and galena. For its high metal content this occurrence deserves attention.

4. Gigezeler ore occurrence. — The Fe, Zn, Cu, Pb sulphide vein is intersected by an intrusion of young diabase. Both sediments strike NNW-SSE dipping towards SW at an angle of 40°.

North of diabase breach the ore vein of similar character was identified, too. It strikes NW - SE and is mostly composed of sphalerite and chalcopyrite.

5. *Talat'ın madeni ore occurrence.* — Lies north of the road at Dereiçi. Andesitic rock containing ore is intensely argilized and partly silicified and pyritized. The ore was identified in a channel distinctly showing the character of occurrence. The width is 6 m and strikes N-S. The boundary between the ore body and andesite is sharp at the east and gradual at the west. Ore occurs in form of crack filling along the fault zone and in form of stockwork and impregnations. Metallic minerals are pyrite, chalcopyrite, sphalerite and galena and non-metallic one is quartz. It is evident that sphalerite is the predominant mineral. Chalcopyrite is noticed in form of exsolutions and galena in form of veinlets in sphalerite. The chemical analysis taken by means of a channel sample assayed Cu 0.15 %, Zn 2.62 %, Pb 0.37 %. 10 m below the ore deposit was intersected by a shaft in which the tendency of thinning out was present.

6. Dereiçi ore occurrence. — In the village of Dereiçi right from Meydancık Ç., there is an outcrop of an ore vein in altered andesite. It is 0.50 m thick and strikes WNW-ESE dipping towards NE at an angle of 50°. Due to cover the vein could not be traced up. Sphalerite prevails with galena abundant and much less chalcopyrite. Non-metallic minerals are quartz and still less carbonates. Metalcontent in the ore vein at the outcrop is: Zn 8.34 %, Pb 2.38 %, Cu 0.99 %.

In the Dereiçi village also but on the left of the Meydancık Ç., chalcopyrite, sphalerite and galena occur. Mineralization is in hydrothermally altered and argilized andesite. It is shown in forms of large and small veins. The thickness of the mineralized zone is about 3 m. Ore occurrence strikes E-W dipping southward at an angle of 75°. Due to the debris coverage the vein could not be traced all along its length. The samples taken by means of a channel sample assayed less metal than the preceding one.

Similar mineral occurrences are identified at the localities of *Tariyadere* (7), *south - east o Binektaşı* at the distance of 500 m and from Biril M. (8) where four mineral veins occur, notably in a very inaccessible locality. Both localities lie in andesite, highly hydrothermally altered. The chemical analyses assayed relatively low metal content.

Type II

Chalcopyrite-pyrite ore occurrences are also identified in tectonic breccias along the faults. These occurrences are discovered at the localities of Hasan'ın açması, Yeni açması and Köpek Dere. In the tectonic andesitic breccia there is chalcopyritic mineralization with pyrite and very scarce sphalerite. The ore deposit is not uniform and occurs in form of filling in cracks and fissures and impregnations.

At the surface these mineral occurrences are manifested in form of yellow-red and green colours resulting from the transformation of pyrite and chalcopyrites into limonite and malachite. At this locality there are extensive ore veins of this type some of which used to be mined even (1972-1973).

9. *Hasan'ın açması ore occurrence.* — Occurs in tectonic breccia of amygdaloidal andesite along the fault which strikes WNW-ESE and dips towards south at an angle of 85°. The ore vein can be traced on the surface by about 90 m in length.

The ore is about 1.20 m thick and the copper content exceeds 2 %. In the course of investigation and mining two tunnels were made. In the upper horizon (1420 m) the ore vein was traced through a tunnel, 82 m long and at the lower horizon along the 42 m long tunnel. The mining works showed that ore vein thinned out and metal content dropped with the depth.

10. *Yeni açması ore occurrence.* — Also lies in the faulted breccia of amygdaloidal andesite. The mineralization is manifested in form of veins and veinlets and chalcopyrite and pyrite impregnations with some sphalerite. The ore vein strikes WNW-ESE dipping northward at an angle of 85°. The thickness changes very much from several cm to 2 m. The vein is uniformity rich both along the strike and dip.

11. *Tarlasırtı ore occurrence.* — Is associated with the faulted andesite breccia. Intense mineralization frequently alternates with poorer one. So changing the thickness reaches 4 m. The vein can be traced 50 m on the surface while further it is covered with debris. The identified minerals are chalcopyrite, pyrite and very scarce sphalerite. Along the channel sample assayed Cu 0.99 % and Zn 0.33 %.

12. *Köpek Dere ore occurrence.* — In the stream profile erosion had outcroped a vein 1 m thick with chalcopyrite. The vein is striking WSW-ENE and dipping southward at an angle of 64°. The ore vein could be traced along 10 m and is covered by debris. The chemical analysis assayed Cu 3.47 % and Zn 1.20 %.

13^{th} *and* 14^{th} *ore occurrences.* — Similar mineral occurrences are registered at the locality of Kopek Dere. They lie in tuffaceous sandstones and andesitic microbreccias along the faults.

15. Sakondriyat ore occurrences. — Lies in andesitic breccias and tuffs and is also associated with the fault breccia striking N-S and dipping eastward at an angle of 80°. The ore vein contains pyrite, chalcopyrite, galena and some sphalerite. Quartz is frequently present. The metal content as proven in the channel sample assays: Cu 1.16 %, Pb 3.30 %, Zn 0.73 %. This ore vein was followed along 10 m and reached 1 m in thickness.

16^{th} *ore occurrence.* — North of the phenomena described a similar mineral occurrence was registered (16) with minor copper content (Cu 0.9 % and Zn 0.30 %). Then at the locality of Akkavak Y. - Tepebaşı in the same rocks, there are several veins of galena and sphalerite. According the field investigations and the results of chemical analyses these occurrences have no economic importance.

Type III

This type of mineralization is characteristic for its quartz veins with chalcopyrite and pyrite and less sphalerite. They lie in amygdaloidal andesite. They very in length and thickness and in the intensity of mineralisation. The contact of quartz veins and andesite is generally sharp but there are parts in the quartz mass in which andesitic origin can be noticed.

The veins mostly consist of white crystalline quartz, then porous quartz with voids filled with limonite. The pyrite and chalcopyritic mineralization occurs in the quartz mass in form of minor impregnations and crack and fissure fillings. The medium copper content is relatively low.

17. *Kaya'nın madeni ore occurrence.* — At this locality, two parallel quartz veins were discovered. They lie about 3 m apart. One vein is 1.84 *m* thick and the other 1 m. The thicker vein can be traced along 160 m on the surface and it strikes NW-SE. The ore contains pyrite, chalcopyrite and sphalerite. Galena is scarce. Of non-metallic minerals the main ingredient is quartz. Chemical analysis in a cutting at the level of 1320 m and from both veins assayed as

follows: Cu 0.62 %, Zn 0.59 %, Pb 0.098 %. At the level of 1305 m one tunnel was made to intersect both ore veins 4 m apart. One is 1.67 m thick and the other 3 m. The average metal content is Cu 0.37 %, Zn 0.46 % Pb 0.04 %. The second tunnel at 1274 m cut an ore vein 1.5 m thick. The ore at this level is the richest in copper (Cu 3.28 %) with some zinc (Zn 0.34 %). This shows that the thickness declines with the depth and the copper content rises.

18th ore occurrences. — May be considered as a part of the ore occurrence no. 17 which is intersected by late intrusions of hornblende andesite. This ore vein has the same strike (NW-SE) and vertical dip. It is 3.90 m thick. Its average metal content is: Cu 0.92%, Zn 0.46 %,Pb 0.04%. The character of this ore vein can be seen on the vertical section (Fig. 2).

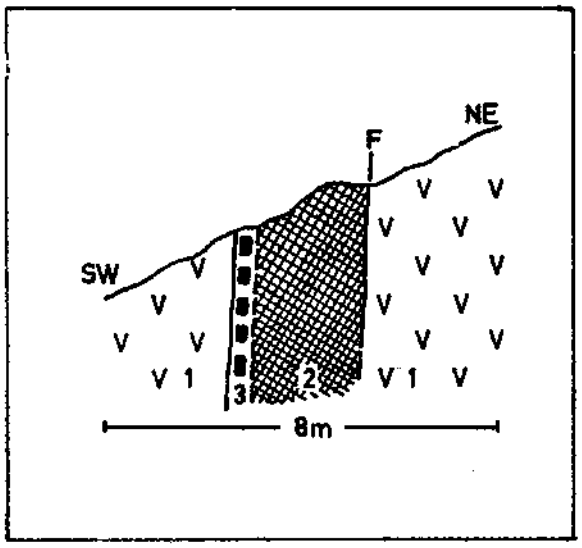


Fig. 2 - The ore vein; cross section in Kaya'nın madeni 18. 1 - Amygdaloidal andesite; 2 - Quartz vein with chalcopyrite and sphalerite; 3 - Intense pyritization; F - Fault.

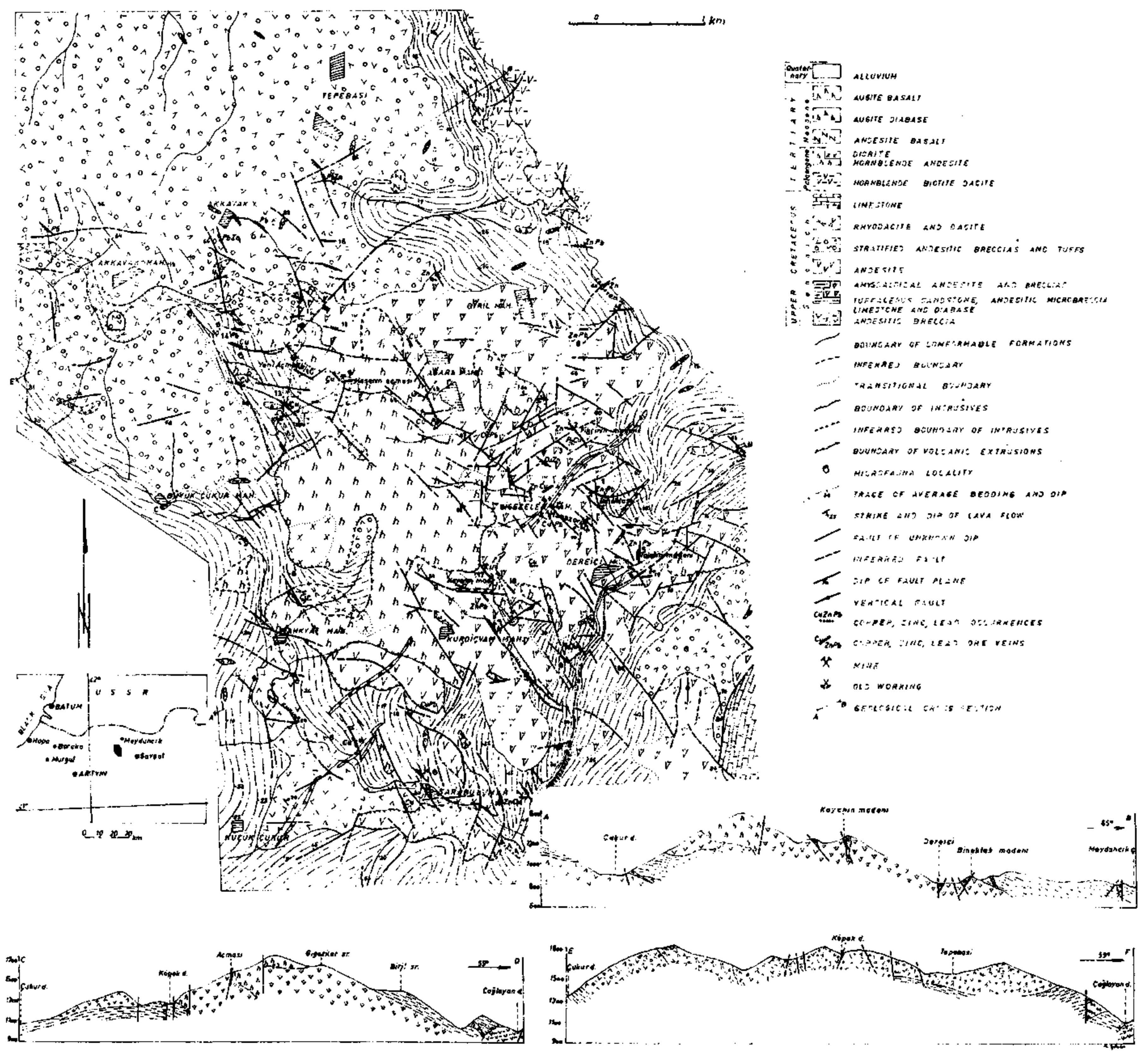
The above shows that a number of ore veins was known at the investigated area. Some were only investigated and some even mined in 1972-1973 by the BAMAŞ company. In the course of our investigations all ore veins identified were geologically treated in detail. Besides, a number of new ore veins and mineral occurrences were identified.

The following new ore veins and occurrences were identified: Dereiçi (6), Yeni açması (10), Tarlasırtı (11), Köpek Dere (12, 13, 14), Sakondriyat (15, 16), of numerous mineral occurrences assessed as economically insignificant we mention: Akkavak Y., Tepebaşı and Biril M., where a number of Pb - Zn sulphide occurrences were identified. At the locality of Şarapul M. and right from Meydancık Ç. a large number of sulphide Cu - Zn mineralizations were also discovered.

METALLOGENESIS

Sulphide polymetallic (Cu, Zn, Pb) mineralizations are associated with faulted structures in the rock of amygdaloidal andesite and stratified andesitic breccias and tuffs, their age to our thinking being the Santonian-Maestrichtian. They are very much altered hydrothermally (intense argilization and silicification) and some ore veins are intersected by hornblende andesite (Kaya'nın madeni). This points lead to a conclusion that sulphide polymetallic mineralizations happened in the

GEOLOGICAL-STRUCTURAL MAP OF DEREİÇİ-TEPEBAŞI AREA, WNW OF ŞAVŞAT (NE TURKEY)



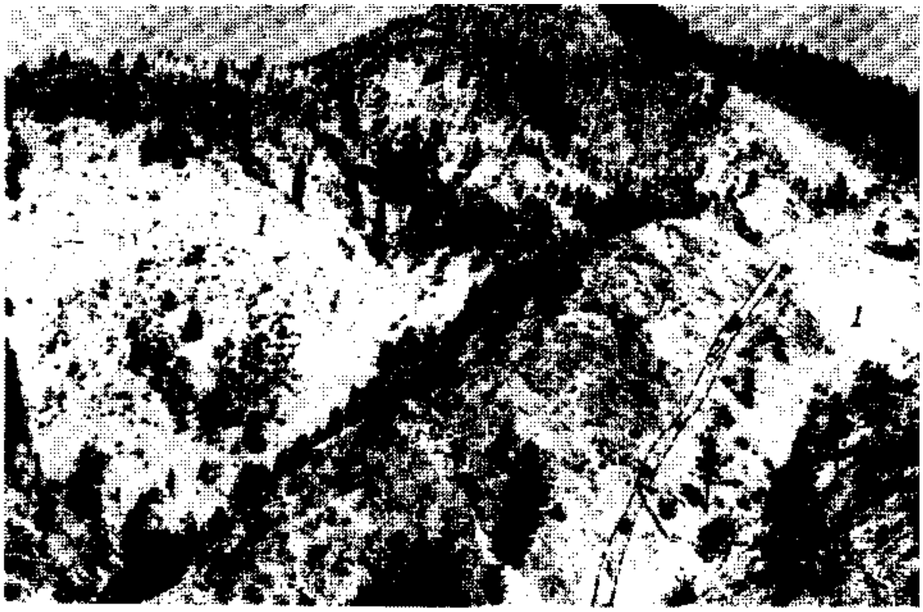


Photo 1 - Fikri'nin madeni.

1 - Bleached amygdaloidal andesite and breccias, strongly argilized;

2 - Ore vein with mining works.

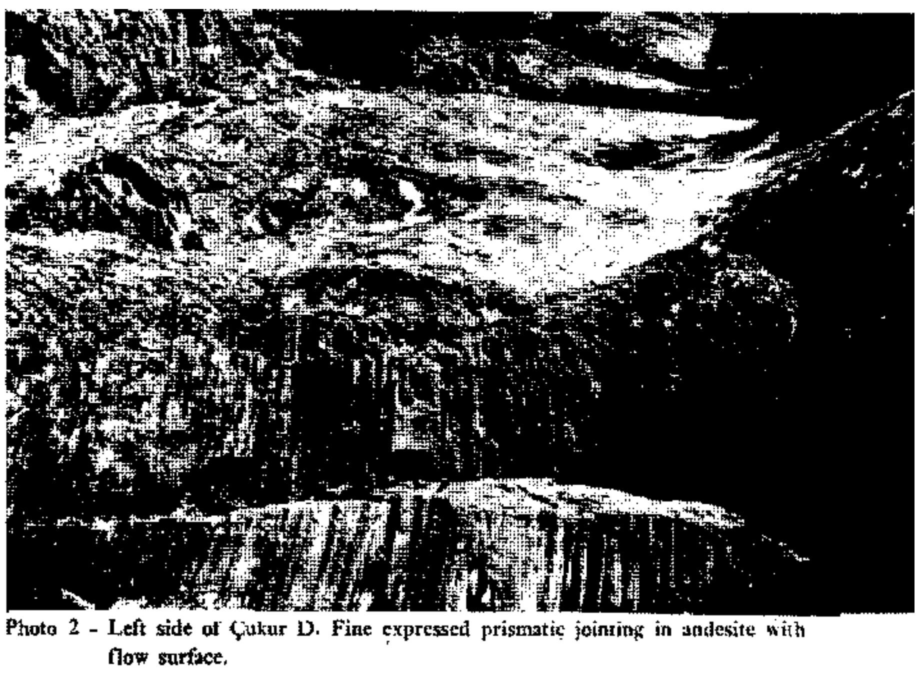


Photo 2 - Left side of Çukur D. Fine expressed prismatic jointing in andesite with flow surface.

Photo 3 - The profile along the road, left of the Çağlayan D.
1 - Andesitic microbreccia and tuffaceous sandstone; 2 - Hornblende biotite dacite.

Photo 4 - North of Yeni açması. Prominent outcrops of hornblende andesite with expressed columner jointing, strongly cataclized.

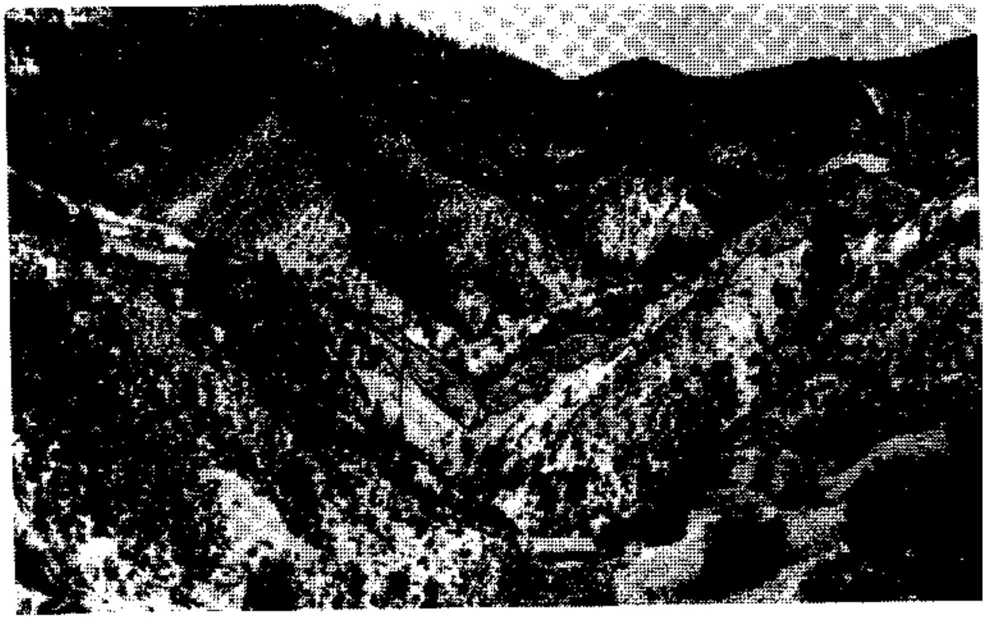


Photo 5 - North of Dereiçi M. 1 - Hydrothermally changed amygdaloidal andesite and breccias;
2 - Great wall like diabases cutting river profile.

Photo 6 - Fikri'nin madeni, the view at the sulphide Zn, Pb, Cu ore vein
and mining works.

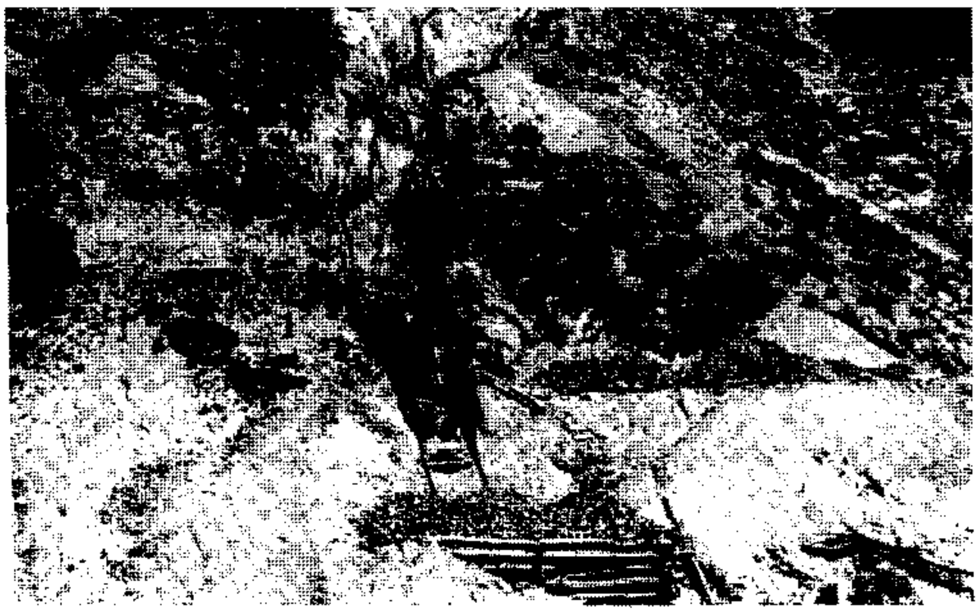


Photo 7 - Hasan'ın açması; left side of spring.
1 - Amygdaloidal andesite; 2 - Ore vein and mining works.

interval between the Uppermost Maestrichtian and the beginning of Eocene, i.e. probably in Paleocene.

The mineralizations are hydrothermal and of vein-type and were created in mezzothermal stage. No scarn occurrences or high-temperature minerals were formed. These veins of copper, zinc and lead sulphides are accompanied by aboundant pyrites and quartz.

On the basis of the geological way of occurrence and mineral composition all ore occurrences are subdivided into three types: 1- Complex sulphide mineralizations (Cu, Zn, Pb); 2- Chalcopyrite-pyrite mineralizations and 3 - Quartz veins with chalcopyrite and pyrite.

According to Sopko (1971) these ore deposits lie in volcanic rocks near to the contact of intrusive mass of gabbro-diorite composition. The presence of diorite was identified in the investigated area, too.

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COULD A COMPLETE SOLID SOLUTION BETWEEN AIKINITE AND BISMUTHINITE EXIST ?

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ABSTRACT. — During the study of polymetallic sulphide veins in Bulancak (Giresun, Turkey) the presence of aikinite (Cu Pb BiS3) was identified by means of x-ray diffraction, optical studies, and electron probe microanalysis methods.

Minerals identified as aikinite have compositions which are not in agreement with the theoritical aikinite compositions. They are suggested to be members of the aikinite-bismuthinite solid solution series and are close to the aikinite end member.

As a result of these studies it was shown that every solid solution composition is possible between aikinite and bismuthinite.

INTRODUCTION

The subjects of the authors previous papers were the geology, formation temperatures, salinity and density, of ore - bearing solution giving way to the sulphide veins to the south of Bulancak (Akıncı, 1974; 1975; 1976a; 1976b). During the study of samples collected from five separate sulphide veins the presence of aikinite minerals was identified for the first time in Turkey by the author.

MATERIALS STUDIED

The colour of the aikinite in the studied samples is hardly distinguishable from that of galena. When enclosed in sphalerite and pyrite, aikinite shows greyish or dull colours and weak anisotropy. In contrast, when associated with chalcopyrite and digenite, it appears pinkish and much brighter with a strong anisotropy. Reflection pleochroism is distinct. Cleavage is in one direction and distinctive when digenite and covellite replace the mineral along cleavage planes. Elongated, lath-like, prismatic forms and xenomorphic grains are common.

Under crossed polars polarisation colours change from deep bright blue to bright yellowish-green or yellowish - brown depending on the orientation of the grains and possibly on the bismuth content.

It shows a coarse polycrystalline texture with grains oriented parallel to the prismatic direction and was seen cutting across a twin lamellae of chalcopyrite.

Aikinite grains are commonly found enclosed in chalcopyrite as rounded or elongated forms or as an island in digenite which is enclosed in chalcopyrite (Photo 1).

Digenite always replaces aikinite along cleavage planes or occurs as patches throughout the aikinite grains. Tennantite was fond replacing, veining or surrounding aikinite. It is usually found in association with pyrite and marcasite. It replaces pyrite along grain boundaries and cleavage planes or the replacement may develop from the central part of pyrite crystal along cleavage directions (Photo 2).

Replacement of sphalerite was also observed in one of the samples in which aikinite is in turn replaced by fahlerz. Sometimes aikinite was seen cutting across a quartz- fahlerz boundary in a limonite - digenite intergrowth resulting from the alteration of chalcopyrite which is seen as relics in the limonitic groundmass.

X-RAY DIFFRACTION PATTERN

Unit cell parameters of one of the samples, of which composition was established by electron probe microanalysis, was measured with the powder photography method explained previously (Akıncı, 1976b). The cell parameters as seen in table 1, are in agrement with those of the Berezovsk aikinite given by Peacock (1942).

Table 1 - Unit cell parameters and densities of Bulancak and Berezovsk aikinites

Bulancak (Turkey)	*Berezovsk (Russia)*
a = 11.297 A°	11.30
b = 11.654 A°	11.64
c = 4.061 A°	4.00
Volume = 534.650 $A^{\circ 3}$	p Measured = 7.22
Calculated p = 7.66	p Calculated = 7.08

The details of various diffraction patterns were given in Table 2.

Peacock (1942) noted that «the aikinite from Berezovsk had a spacing at d 2.36 A° which does not correspond with any possible set of planes in the mineral although it does agree with the strongest reflection in the diffraction pattern of gold which is reported to exist together with aikinite». This spacing, however, was found to occur in all aikinites shown in table 2. It therefore seems unlikely to be due to gold; x-ray diffraction pattern suggest that it is due to the 411 plane reflection.

Table 2 - X-Ray diffraction data for aikinites

*hkl**	*Bulancak*	*Berezovsk (Russia)*[1]	*Dzhido (Russia)*[2]	*Gladhammer (Sweden)*[3]
120	5.16	—	5.20	—
—	—	—	—	4.862
—	—	—	4.54	—
220	4.04	4.07	4.07	4.069
101, 011	3.80	3.77	—	3.82
130	3.66	3.67	3.66	3.716
111	—	—	—	3.626
310	3.59	3.58	3.58	3.600
021, 201	3.29	—	—	3.328
121	—	3.18	3.18	3.194
211, 320	3.170	—	—	3.171
040	—	—	—	2.915
221	2.856	2.88	2.85	2.87
140	—	—	—	2.84
410, 301	2.745	2.74	2.73	2.764
313, 330, 311	2.673	2.68	2.68	2.713
240	2.585	2.580	2.590	2.594
420	—	2.56	2.55	2.553
231, 321	2.498	2.510	2.510	2.513

Table 2 - (Continued)

hkl*	Bulancak	Berezovsk[1]	Dzhido[2]	Gladhammer[3]
041	—	—	2.40	—
411	2.356	2.36	2.36	2.366
150, 340	2.301	—	2.30	2.314
—	—	2.27	2.27	2.278
510	—	—	—	2.25
241	2.174	2.17	2.190	2.183
250, 421	2.145	2.15	2.16	2.157
440, 051	2.015	2.02	2.03	2.024
431, 151	1.985	1.984	1.99	1.993
501, 151	—	—	—	1.979
530, 112, 511	1.9456	1.947	1.952	1.959
202, 600, 212	1.8778	1.883	1.888	—
441	1.8041	1.805	—	—
312, 351, 132	1.7638	1.766	1.766	—
360	1.7231	—	1.731	—
261	1.670	—	1.680	—
621, 042, 170	1.6369	1.648	1.647	—
270, 710	1.5919	1.593	1.598	—
720	1.5536	—	1.564	—
370, 342	1.5208	1.524	1.525	—
730, 461	1.4867	1.488	1.490	—
560	1.4697	1.475	1.478	—
721	1.4488	—	1.455	—
—	—	—	1.425	—
062	1.4017	1.406	1.417	—
—	—	—	1.395	—
651	1.3758	1.380	1.370	—
471	1.3518	1.354	1.345	—
—	—	1.330	1.323	—
632	1.300	1.302	1.295	—
840, 133	1.2688	1.271	2.265	—
—	—	—	1.241	—
481	1.232	—	1.232	—
413	1.2127	1.216	1.216	—
—	—	—	1.204	—
—	—	—	1.192	—
053, 472	1.1704	1.174	1.170	—
513	1.546	1.158	1.157	—
—	—	—	1.138	—
—	—	1.123	1.125	—
—	—	—	1.120	—
603	1.0983	—	—	—
591	1.0815	1.083	1.084	—
—	—	—	1.078	—
—	—	—	1.069	—
690, 902	1.0661	—	1.0640	—
4.10.1	1.0467	—	1.049	—
—	—	—	1.041	—
—	—	—	1.031	—
—	—	—	1.027	—
723,1.11.1	1.0205	1.020	1.018	—
—	—	—	1.010	—
—	—	—	1.000	—
653	0.9928	—	0.992	—
183	0.9869	0.989	0.986	—
813, 971	0.9725	0.975	—	—
823,6.10.1	0.9613	—	—	—

[1] Peacock, 1942.

[2] Wclin, 1966.

[3] Welin, 1966.

* Few extra lines were taken from other authors and included in the list.

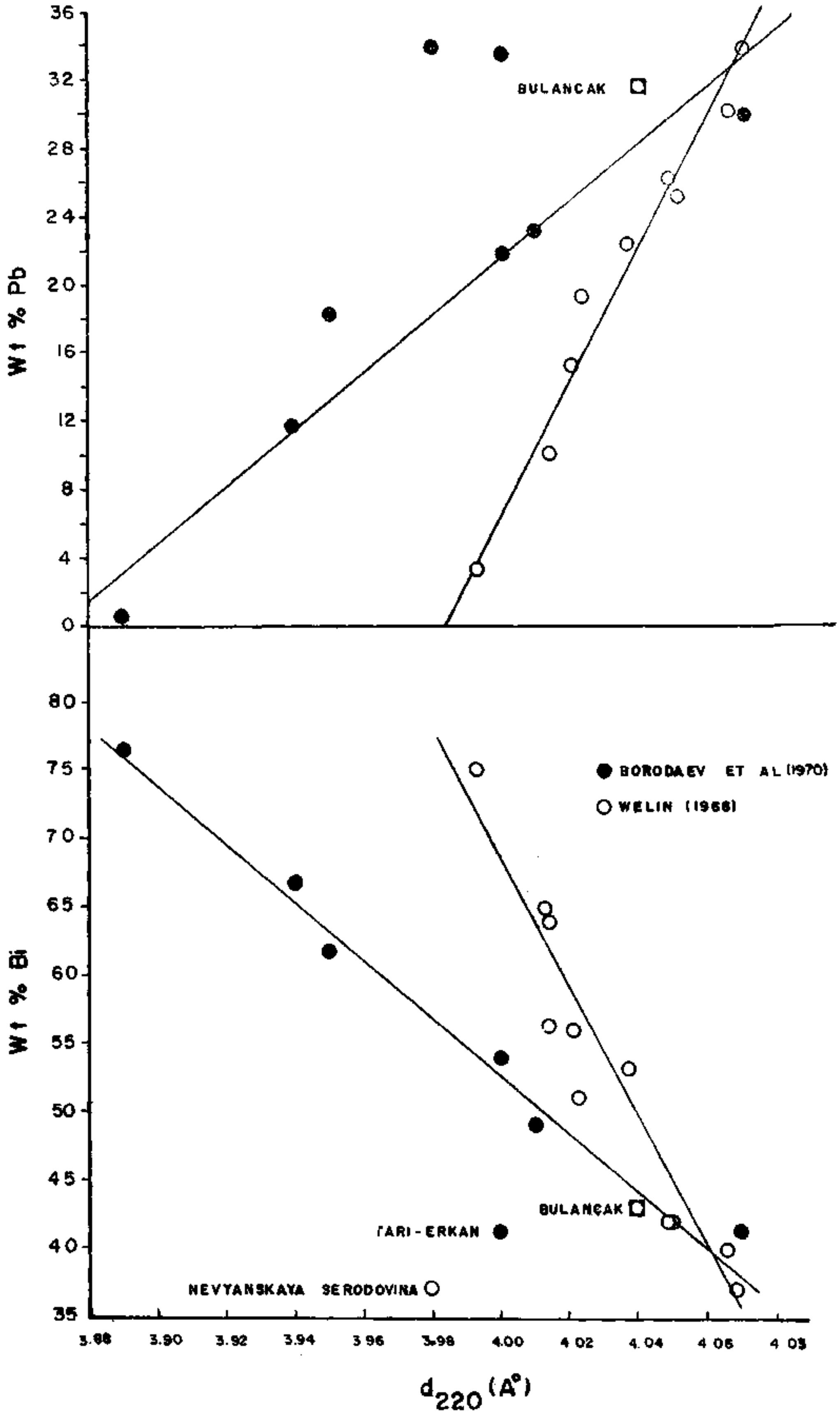

Fig. 1 - The relationship between d_{220} and Bi-Pb contents of aikinite-bismuthinite solid solution minerals.

Welin (1966) has demonstrated a linear relationship between d_{220} of aikinite-bismuthinite minerals and their Pb content. The Pb and Bi contents of these minerals from Gladhammar (Sweden) and Russia (Borodaev *et al.*, 1970) were plotted against d_{220} values together with that of Bulancak aikinite in Fig. 1. A better correlation was obtained, for both elements, from the data given by Borodaev *et* al., *(op. cit.)* in comparison to Welin's (1966) data. The only data given for Tari - Erkan and Newyanska Seredovina aikinites are scattered. Curves obtained from Russian and Swedish aikinites intersect at 4.07 A° (d) for an equivalent of 33.5 % Pb, both curves diverging into bismuthinite field because the given d_{220} values, for bismuthinite of both authors are different.

ELECTRON MICROPROBE ANALYSIS

Since the method of the microprobe analysis of the five aikinite samples was explained in an earlier paper (Akıncı, *1916b)* it will not be repeated.

The aikinite analysis given in table 3 do not exactly correspond to the theoretical aikinite composition but the plot is close to the aikinite end member in the PbS-Bi_2S_3-Cu Pb BiS_3 sub-ternary (Fig. 2).

Table 3 - Electron microprobe analyses of aikinites

	1a	1b	20	25	50	*Theoretical aikinite*
Cu	11.80	10.55	10.22	10.20	10.70	11.00
Pb	35.76	34.40	31.39	32.18	34.45	36.00
Bi	36.00	39.85	42.94	41.95	39.64	36.30
Ag	0.00	0.0	0.0	0.0	0.0	—
S	16.20	15.40	15.75	15.83	16.27	16.70
Total	99.76	100.20	100.30	100.21	101.06	100.00

Ia	$Pb_{1.02}$ $Cu_{1.10}$ $Bi_{1.02}$ S_3
Ib	$Pb_{1.03}$ $Cu_{1.19}$ $Bi_{1.03}$ S_3
20	$Pb_{0.98}$ $Cu_{1.25}$ $Bi_{0.93}$ S_3
25	$Pb_{0.97}$ $Cu_{1.22}$ $Bi_{0.96}$ S_3
50	$Pb_{1.0}$ $Cu_{1.10}$ $Bi_{0.98}$ S_3
Theoretical	$PbCuBiS_3$

DISCUSSION ON THE AIKINITE - BISMUTHINITE SOLID SOLUTION SERIES

Bismuth minerals constitute approximately one - fifth of the known sulphosalts yet have received less attention than other sulphosalt groups. Aikinite was known to Mohs (1804) but has recently assumed increased importance in understanding the crystal chemistry of the bismuth sulphosalts. Its structure has been studied by many workers (Peacock, 1942; Wickman, 1953) and the metal atoms were readily located. Accurate coordinates for the sulphur atoms have, however, only recently been located by Kohatsu and Wuenesch (1971) using a single crystal from Berezovsk, Russia. Other occurrences of aikinite have been reported from Russia (Berezovsk, Dzhido), Sweeden (Gladhammar), Greenland (in Ivigtut cryolite deposit by Karup - Moller, 1973), Greece (Nicolaou & Hakli, 1970) and England (Kingsburry & Hartley, 1953).

Due to the similarity between both the space groups and cell dimensions for aikinite and bismuthinite (Peacock, 1942) Padera (1955) suggested the use of a common name Rezbanyite (Fig. 2) for intermediate aikinite - bismuthinite solid - solution minerals. These include such compositions as Gladite, Pb Cu Bi_5 S_9; Hammarite, Pb_2Cu2Bi_4S9 and Lindstromite, Pb Cu Bi_3S_6. Another intermediate $Pb_3Cu_3Bi_7S_{15}$ was recently described by Welin (1966) who demonstrated the development of superstructures after single crystal x-ray work on these intermediate members from the Gladhammar deposits. Recently Mumme, Welin and Wuench (1976) have shown that this intermediate composition is krupkaite and rezbanyite composition is actually Lindstromite. Welin *(op. fit.)* is also concluded that solid - solution between bismuthinite and aikinite is not continuous but that only discrete compositions are possible. He also suggested a structural classification for this solid - solution series.

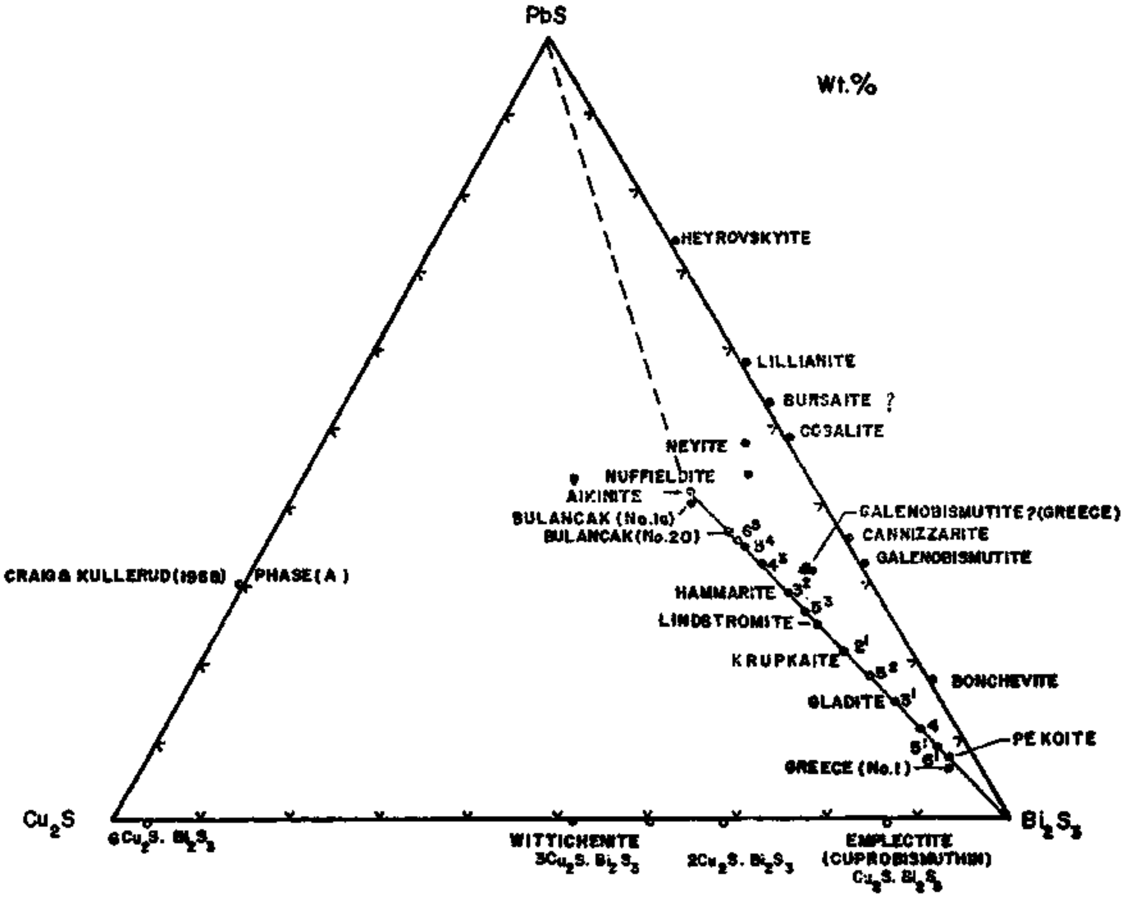

Fig. 2 - The system PbS-Cu_2S-Bi_2 S_3 showing naturally occurring compositions (solid circles) including minerals from the Bulancak area. Numbers represent zn aikinites according to Moore (1967).

A classification was established by Moore (1967) Table 4. As aikinite is considered to be compositional limit of Pb: Bi substitution there are no extra cavities remaining to accommodate copper. Retaining aikinite as the limit of the series, Moore *(op. fit.)* referred to the intermediate members as Z_n aikinite where n=x/4 is the number of the lead(or copper) atoms in the asymetric unit cell smaller than Z; hence Z=l,x=4, n=l in aikinite Gladite $=3^1$ aikinite, Hammarite 3^2 aikinite.

«Z» is defined, as the integral multiple of the (a) translation in aikinite, without changing (b) and (c) parameters, for the superstructure with 4Z > x restriction in the general cell formula, $Cu_xPb_xBi_8z\text{-}_xS_{12}z$, for the aikinite derivatives.

The analysis of Bulancak aikinites indicate at least complete solubility between Dzhido aikinite, which is practically the nearest composition together with Berezovsk aikinite to the ideal aikinjte and the 6^5 aikinite composition calculated by "Moore (1967). Specimen, no. 20 has an almost identical composition to 6^5 aikinite (See table 4).

Springer (1971) has demonstrated complete solid solution between bismuthinite and aikinite in the temperature range from 300°C upwards to the melting and breakdown points. The temperature of formation may control the derivation of superstructures. Springer *(op. cit.)* could not, however, detect the superstructures which has been observed by Welin (1966) in natural specimens. This may be due to the rapid cooling under the laboratory conditions.

Table 4 - Compositions of bismuthinite derivatives* recalculated as molecular percent Bi_2S_3, PbS, Cu_2S.

Composition	*Zn*	*Bi_2S_3*	*PbS*	*Cu_2S*	*Mineral*	*Locality*
Bi_2S_3		90.16	6.80	3.25	Bizmuthinite	
$CuPbBi_{11}S_{18}$	6_1	89.90	9.15	3.00	Pekoite	Australia
$CuPbBi_9S_{15}$	5_1	87.85	9.15	3.75	—	Theoretical
$CuPbBi_5S_9$	4_1	85.15	12.95	4.65	Gladite	Russia
		80.10	14.90	5.00	Gladite	Theoretical
		79.33	14.32	5.75	Gladite	Greece
$CuPb_3Bi_3S_6$	2_1	71.30	21.30	7.40	Krupkaite	Australia
		73.82	19.50	7.40	Krupkaite	Russia
$Cu_3Pb_3Bi_4S_{15}$	5_3	66.42	24.83	8.25	Lindstromite	Dobsina
		65.60	25.40	9.00	Lindstromite	Australia
$Cu_2Pb_2Bi_4S_9$	3_2	61.75	28.75	9.50	Hammarite	Russia
		60.27	25.79	9.61	Hammarite	Theoretical
$Cu_3Pb_3Bi_5S_{12}$	4_3	57.35	32.00	10.65	—	Theoretical
$Cu_4Pb_4Bi_6S_{15}$	5_4	54.75	34.00	11.25	—	Theoretical
$Cu_5Pb_5Bi_7S_{18}$	6_5	53.00	35.25	11.75	—	Theoretical
		52.82	35.00	12.77	—	Present Study no.20
		51.60	35.88	12.75	—	Present Study no.25
		49.00	38.80	13.20	Aikinite	Present Study no.1b
		48.76	38.41	13.37	Aikinite	Present Study no.50
		44.28	39.87	14.75	Aikinite	Present Study no.1a
$Cu_2Pb_2Bi_2S_6$		45.15	40.85	14.00	Theoretical	Aikinite Composition
		46.13	38.02	15.25	Aikinite	Dzhido
		41.62	41.58	13.62	Aikinite	Berezovsk

* After Welin (1966), Moore (1967), Mumme (1975) and Mumme, Welin and Wuench (1976).

Recently discovered aikinite - bismuthinite solid solution series in Greece (Nicolaou & Hakli, 1970) range between 6^1 aikinite (analysis no. 1) and 5^3 aikinite (Analysis no. 6). Their galenobismuthinite analysis falls within the range Hammarite and Cannizzarite on the Bi_2S_3- PbS-Cu Pb BiS_3 subternary (Fig. 2). Finally, although Welin (1966) states that in fact every composition in the series bismuthinite - aikinite seems to be possible. Concequently no continuous solid solution series exists» present study ofBulancak natural sulphide specimens shows every solid-solution composition is possible between aikinite and bismuthinite. Mumme, Welin and Wuench (1976) propose that the z^n classification be discontinued.

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Photo 1 - Chalcopyrite (C) and marcasite (M) relationship withe Aikinite (A) as island in Digenite (D), X 100.

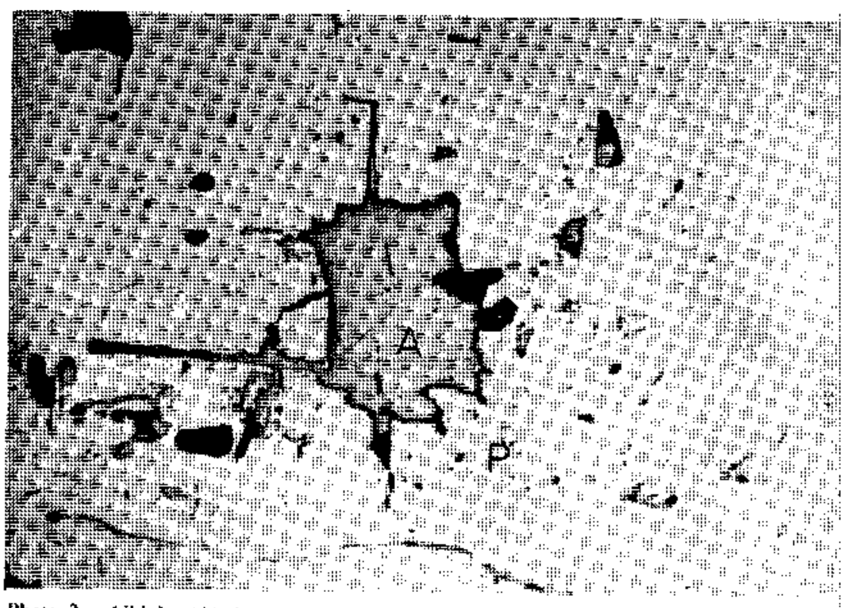

Photo 2 - Aikinite (A) development in pyrite (P) along cleavage Planes. X 100.

AURICULIMEMBRANISPORA: UN NOUVEAU GENRE DE SPORE PROVENANT DU DEVONIEN SUPERIEUR DE LA COUPE DE DÜZAĞAÇ (KOZAN-ADANA-TURQUIE)

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RESUME. — II est question dans cet article de decrire un nouveau genre *(Auriculimembranispora)* avec ses especes *(A. radiata* et *A. undulata)* recueillis dans une coupe geologique du Devonien superieur des Taurus.

INTRODUCTION

Une coupe geologique, celle de Düzağaç (Kozan-Adana), faite au plein milieu des Taurus par B. Özer, est echantillonnee en vue de datation palynologique. Les echantillons sont riches en spores du Devonien superieur qui constitueront le sujet de publication ulterieure. Le premier abord de l'etude revele un nouveau genre : *Auriculimembranispora.*

PLACEMENT DANS LA CLASSIFICATION

Ce genre renferme des spores triletes camerates. L'attachement de l'exoexine a l'intexine se fait par la face distale debordant un peu sur la face proximale. Tout le long de l'equateur de 1'intexine, on observe une chambre circulaire de decolement.

La classification supragenerique proposee par Neves et Owens (1966) etant usee dans ce travail, nous l'y plaçons de la façon suivante:

Anteturma : SPORITES H. POTONIE, 1893
Turma : TRILETES (REINSCH, 1881) DETTMANN, 1963
Suprasubturma: CAMERATITRILETES NEVES & OWENS, 1966
Subturma : MEMBRANATITRILETES NEVES & OWENS, 1966
Infraturma : CONTINUATI NEVES & OWENS, 1966

Genotype: Les travaux microscopiques de l'etude palynologique de la coupe de Düzağaç sont executes dans les laboratoires de T.P.A.O. (Compagnie Petroliere de Turquie). La lame portant *le genotype (Auriculimembranispora radiata)* dont la figuration est reportee sur la Planche I, figure 1, est deposee a ce dit laboratoire.

Diagnose: Spores triletes, camerates. Intexine de forme circulaire ou triangulaire fortement convexe. Marque en Y toujours nette. Exoexine etroite dans les zones interradiales, prolongee en forme de languette aux zones radiales et ornee de microreticulations irregulieres.

Description: Ce sont des spores triletes, camerates. L'intexine de couleur brun fonce, est circulaire ou triangulaire aux cotes fortement convexes. Elle porte une marque trilete bien visible. Le caractere essentiel de ces spores est que l'exoexine presente des prolongements en forme de languette aux zones radiales, rappelant des *auriculae.* Elle est etroite aux zones interradiales, jaune claire et pourvue d'ornements microreticules constituant un reseau a mailles imparfaites.

Comparaison: Les spores de ce nouveau genre.sont facilement connues par leurs prolongements auriculaires de l'exoexine places aux zones radiales de la spore.

Especes de *Auriculimembranispora:* Au cours des etudes, on a pu deceler deux especes appartenant a ce genre:

Auriculimembranispora radiata n. sp. (PI. I, fig. 1,2)

Holotype: PI. I, fig. 1.

Diagnose: Spores triletes, camerates, circulates ou triangulaires fortement convexes. Marque trilete nette, de longueur egale a 1/3-2/3 du rayon de l'intexine. Intexine de couleur foncee, pourvue de cotes radiales, fines a l'apex et s'elargissant vers l'equateur. Exoexine a microreticulation imparfaite, Stroke aux zones interradiales et prolongee en forme de languette aux zones radiales. Diametre de l'intexine entre 50-60 microns et la taille de la spore, entre 70-110 microns.

Description: Il s'agit de spores triletes et camerates. L'intexine de couleur brun fonce, est circulaire ou triangulaire aux cotes fort convexes. Elle porte une marque en Y bien nette dont les branches fines et rectilignes s'allongent jusqu'a 1/3-2/3 de son rayon et presente des cotes radiales qui sont fines a l'apex et s'elargissent vers l'equateur. L'exoexine qui est d'une couleur jaune claire possede une microreticulation a un reseau de mailles imparfaites et des prolongements auriculaires aux zones radiales, son epaisseur aux zones interradiales etant minimante. L'intexine mesure entre 50-60 microns et toute la taille de la spore, entre 70-110 microns.

Auriculimembranispora undulata n. sp. (PI. I, Fig. 3,4,5)

Holotype: Pl. I, fig. 3.

Diagnose: Spores triletes, camerates, circulates ou triangulaires fortement convexes. Marque trilete nette, de longueur egale a 1/3-2/3 du rayon de l'intexine. Intexine de couleur foncee, chagrinee ou pourvue de ponctuations et de granulations. Exoexine a microreticulation imparfaite, etroite aux zones interradiales et prolongee en forme de languette aux zones radiales. Diametre de 1'intexine entre 50-65-microns et la taille de la spore, entre 75-90 microns.

Description: Il est question de spores triletes et camerates. L'intexine de couleur brun fonce, est circulaire ou triangulaire aux cotes fort convexes. Elle porte une marque trilete nette dont les branches fines et rectilignes s'allongent jusqu'a 1/3 r 2/3 de son rayon et peut etre chagrinee ou presenter de ponctuations et de granulations L'exoexine qui a une couleur jaune claire possede une microreticulation a un reseau de mailles imparfaites et des prolongements auriculaires aux zones radiales, son epaisseur aux zones interradiales etant minimante. L'intexine mesure entre 50-65 microns et la taille de la spore, y comprise l'exoexine, entre 75-90 microns.

Comparaisan: Les deux nouvelles especes de *Auriculimembranispora* se distinguent l'une de l'autre, par la difference d'ornementation que montrent leurs intexines. *A. radiata* possede des cotes radiales et *A. undulata* porte des elements d'ornementation de petite taille, l'intexine pouvant etre chagrinee ou avoir de ponctuations et de granulations.

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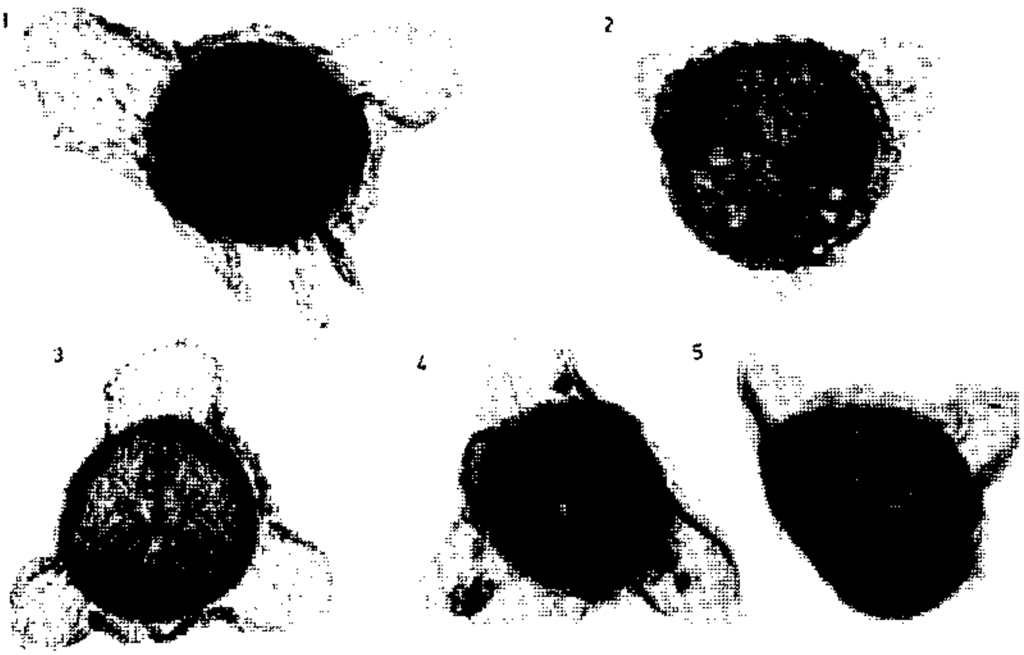

Fig. 1,2 - *Auriculimembranispora radiata* n. gen., n. sp. 500 ×.

Fig. 3,4,5 - *Auriculimembranispora undulata* n. gen., sp. 500 ×.

ETUDE PALYNOLOGIQUE DE L'EOCENE DE BAYAT (ÇORUM-TURQUIE) ET ESSAI DE CORRELATION ENTRE KARAKAYA ET EMİRŞAH

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RESUME. — Parmi les formations coatinentales d'Eocene de la Turquie, celle de Sorgun füt deja etudiee par E. Nakoman. L'auteur nous a ainsi fait connaitre une partie de la microflore eocene.

Par ce travail qui concerne l'Eocene de Bayat, nous emplifions la connaissance sporo-pollinique de ce sous-systeme du Tertiaire. Nous comparons nos resultats avec ceux de Sorgun et de l'Europe. Nous correlons en meme temps les niveaux charbonneux des petites cuvettes de Karakaya et Emirşah.

1. DONNEES GEOLOGIQUES

Les environs de Karakaya et Emirşah de l'Eocene de Bayat, sont cartographies par C. Hezarfen. Il est utile de resumer ici, les donnees stratigraphiques, petrographiques et paleontologiques que ce geologue a bjen voulues me confier[1]:

Dans la partie cartographiee (Fig. 1), on observe comme la formation la plus ancienne, des marnes grises et des schistes non fossiliferes. Son epaisseur moyenne est de 500 m (el).

Celle-ci est recouverte par une formation de 190 m qui est constituee, en generale, de gres (e2). Une epaisseur de 45 m ä partir de sä base se presente sous forme de corniche, ä cause de la durete des gres qui contiennent des galets ä certains niveaux. Plus haut, il existe des bancs de marnes. Les fossiles y sont abondants. Y. Pekmen[2] a determine *Nummulites partschi* de la Harpe, *Nummulites praelucasi* Douville, *Nummulites burdigalensis* de la Harpe, *Nummulites* cf. *globulus* Leymerie, *Assilina douvillei* Abrard et Fabre, *Discocyclina* sp. et attribue l'age Ypresien.

L'Ypresien est surmonte par des gres de 385 m d'epaisseur (e3). Ils sont jaune brun et englobent des galets ä leur base. Vers le haut, une alternance de bancs d'argile grise et de gres brun ä galets predomine. *Ampullina a*ff. *grossa* Deshayes, *Cerithium (Campanile) giganteum* Lamarck, *Turitella a*ff. *trempina* Carez, *Assiminea a*ff. *crassilabris* Deshayes, *Melania* sp. et *Ostrea* sp. determines par A. Güngör[3], donnent l'age Lutetien. Ce Lutetien renferme des veines ou des veinules de lignite.

Et enfin au sommet, une formation de marnes grises de 120 m de puissance (e4), preseritant de minces intercalations greseuses, recouvre le Lutetien.

2. ETUDES PALYNOLOGIQUES

2.1. Contenue microfloristique

Dans les echantillons etudies, nous avons determine les especes suivantes

Groupe : SPORITES H POT., 1893

Division : MONOLETES IBR., 1933

Subdivision : AZONOMONOLETES LUBER, 1935

Serie : Laevigato COR., CAR., DAN. & LAVEINE, 1962

Genre: *LAEVIGATOSPORITES IBR.,* 1933

Genotype: *Laevigatosporites vulgaris (IBR.,* 1932) IBR 1933

Laevigatosporites haardti (R. POT. & VEN., 1934) TH. & PF., 1953 (Pl.,fig. 1,2,3,4,5,6,7).

Laevigatosporites ovatus WILS. & WEBS., 1946 (Pl. I, fig. 13,14,18, 19,20).

Laevigatosporites discordatus PF., 1953 (Pl. I, fig. 8,9,10,11,12,15,16,17).

Serie: Granulato COR., CAR., DAN. & LAVEINE, 1962

Genre: *PUNCTATOSPORITES IBR.,* 1933

Genotype: *Punctatosporites minutus IBR.,* 1933

Punctatosporites paleogenicus KRUTZSCH, 1959 (Pl. I, fig. 21,22,23).

Serie: Vemicato COR., CAR., DAN. & LAVEINE, 1962

Genre: *VERRUCATOSPORITES PF.* & TH., 1953

Genotype: *Verrucatosparites alienus (R.* POT., 1931) TH. & PF., 1953

Verrucatosporites favus (R. POT., 1934) TH. & PF., 1953 (Pl. I, fig. 24,25,26).

Verrucatosporites secundus (R. POT., 1934) KRUTZSCH, 1959 (Pl. I, fig. 32,33,34, 35,36,37,38,39,40).

Verrucatosporites afavus KRUTZSCH, 1959 (Pl. I, fig. 27,28,29,30,31).

Vcrrucatosporitet saalensis KRUTZSCH, 1959 (Pl. I, fig. 41,42,43,44,45,46).

Serie: Murornato COR., CAR., DAN. & LAVEINE, 1962

Genre: *MICROFOVEOLATOSPORIS* KRUTZSCH, 1959

Genotype: *Microfo-veolatosporis pseudodentatus* (KRUTZSCH, 1959) KEDVES, 1961

Microfoveolatosporis pseudodentatus (KRUTZSCH, 1959) KEDVES, 1961 (Pl. I, fig. 47,49,50,51).

Microfoveolatosporis bayatensis nov. sp. (Pl. I, fig. 56,57).

Holotype: Pl. I, fig. 56.

Diagnose: Spores monoletes d'une forme de haricot en position longitudinale, ovales en Position polaire. Fente monolete nette, rectiligne et longue, touchant presque le contour equatorial. Exine ornee de *microfoveae.* Taille comprise entre 45 et 55 microns.

Description: La taille de ces spores varie entre 45 et 55 microns. Les dimensions de l'holotype sont 47 X 33 microns. En vue equatoriale, la face proximale est rectiligne ou faiblement convexe et la face distale fortement convexe a la forme d'un demi-cerde. La fente monolete est nette, longue, rectiligne et touche presque le contour equatorial. L'omementation de l'exine consiste en *foveae* petites et arrondies ayant une disposition serree.

Comparaison: *M. bayatensis* nov. sp. se distingue de *M. pseudodentatus* (Krutzsch) Kedves, par sa taille plus petite et sa fente monolete plus longue et de *M. retis* Nakoman, par sa face proximale rectiligne ou faiblement convexe, sa marque monolete plus longue et sa taille plus grande.

Origine: Karakaya, echantillon 2415.

Genre: *CICATRICOSOSPORITES* PFLUG, 1952

Genotype: *Cicatricososporites pseudodorogensis (R.* POT., 1934) Pf., 1952

Cicatricososporites pseudodorogensis (R. POT., 1934) PF., 1952 (Pl. I, fig. 53).

Cicatricososporites virgatus PF., 1953 (Pl. l, fig. 54,55,58).

Division : TRILETES (REINSCH, 1881) R:POT. & KR., 1954

Subdivision : AZONOTRILETES LUBER, 1935

Serie : Laevigati (BENNIE & KIDSTON, 1886) R. POT., 1956

Genre: *LEIOTRILETES* (KAUM., 1937) R.POT. & KR., 1954

Genotype: *Leiotriletes sphaerotriangultis* (LOOSE, 1932) R.POT. & KR., 1954

Leiotriktts adriennis (R. POT. & GELL., 1933) KRUTZSCH, 1959 (Pl. H, fig. 1,2).

Leiotriletes microadriennis KRUTZSCH, 1959 (Pl. II, fig. 3,4,5,6,7,8,9,10).

Leiotriletes dorogensis (KEDVES, 1960) KEDVES, 1961 (Pl. II, fig. 11,12,13,14,23,33).

Leiotriletes nominis Nakoman, 1966 (Pl. II, fig. 16).

Genre: *PUNCTATISPORITES* (IBR., 1933) R. POT. & KR., 1954

Genotype: *Punctatisporites punctalus* (IBR., 1932) IBR., 1933

Punclatisporites parvopunctatus (WEYL. & GREIF., 1953) nov. comb.

(al. Baculatisporites parvopunctatus WEYL. & GREIF., 1953, p. 42, Pl. 10, fig. 40) (Pl. II, fig. 15,17).

Punttatisporites aquisgranensis WEYL. & KRIEGER, 1953 (Pl. II, fig. 19,20,21,34).

Genre: *UNDULATISPORITES* PFLUG, 1953

Genotype: *Undulatisporites microcxtis* pp., 1953

Undulatisporites brevilaesurtus KEDVES, 1961 (Pl. II, fig. 24,25).

Genre: *CONCAVISPORITES* PFLUG, 1953

Genotype: *Concavisporites, rugulatus* PFLUG, 1953

Conctnisporites arugulatus PF., 1953 (Pl. II, fig. 18,26,27,28,29).

Concavisporites discites PF., 1953 (Pl. II, fig. 30).

Concavisporites acutus PF., 1953 (Pl. II, fig. 31).

Genre: *TOROISPORIS* KRUTZSCH, 1959

Genotype: *Toroisporis torus (PFLUG,* 1953) KRUTZSCH, 1959

Toroisporis minoris NAKOMAN, 1966 (Pl. II, fig. 32,33).

Serie: Verrucati DYB & JACH., 1957

Genre: *TRILITES* COOKSON, 1947 *ex.* COUPER, 1953

Genotype: *Trilites tuberculiformis* Cook., 1947

Trilites solidus (R. POT., 1934) KRUTZSCH, 1959 (Pl. II, fig. 39).

Trilites concavus KEDVES, 1964 (Pl. II, fig. 35,36).

Serie: Apiculati (BENNIE & KIDS., 1886) R. POT., 1956

Genre: *ECHINATISPORIS* KRUTZSCH, 1959

Genotype: *Echinatispons longechinus* KRUTZSCH, 1959

Echinatispons erinacetis (PF., 1953) KRUTZSCH, 1959 (Pl. II, fig. 37).

Echinatisporis minutus nov. sp. (Pl. II, fig. 41).

Holotype: Pl. II, fig. 41.

Diagnose : Spores de petite taille, avec une marque trilete aux branches fines et rectilignes, de longueur de 2/3 du rayon de la spore. Forme triangulaire fortement convexe. Exine ornee de longues epines irregulierement reparties.

Description: Ces spores qui sont de petite taille (holotype: 24 microns), presentent une forme triangulaire fortement convexe. Elles possedent une marque en Y nette dont les branches sont fines et rectilignes et qui s'allongent jusqu'aux 2/3 du rayon de la spore. On observe sur l'exine, de longues epines irregulierement reparties.

Comparaison: *E. minutus* nov. sp. se distingue de *E. triangulattts* Nakoman 1966, par sa fente trilete nette aux branches plus longues et ses epines reparties d'une façon lache et irreguliere et des autres especes d' *Echmatisporis* Krutzsch, par sa petite taille.

Origine: Karakaya, echantillon 2415.

Serie: Baculati DYB. & JACH., 1957

Genre: *BACULATISPORITES PF.* & TH., 1953

Genotype: *Baculatisporites primarius* (WOLFF, 1934) TH. & PF., 1953

Baculatisporites primarius (WOLFF, 1934) TH. & PF., 1953 (Pl. II, fig. 43,44 et Pl. III, fig. 1).

Baculatisporites genınatus KRUTZSCH, 1959 (Pl. II, fig. 45).

Serie: Murornati R.POT. & KR., 1954

Genre: *HAMULATISPORIS* KRUTZSCH, 1959

Genotype : *Hamulatisporis hamulatis* KRUTZSCH, 1959

Hamulatisporis hamulatis KRUTZSCH, 1959 (Pl. III, fig. 13,14).

Genre: *CICATRICOSISPORITES R.POT.* & GELL., 1933

Genotype : *Cicatricosisporites dorogensis R.* POT. & GELL., 1933

Cicatricosisporites dorogensis R. POT. & GELL., 1933 (Pl. III, fig. 2,3,4,5,6,7, 8,9,10,11).

Subdivision: ZONOTRILETES (WALTZ, 1938) R. POT. & KR., 1954

Serie: Cingulati R. POT. & KLAUS, 1954

Genre: *CINGULATISPORITES TH.*, 1953

Genotype : *Cingulatisporites laevispeciosus PF.,* 1953

Cingulatisporites vitiosus (KRUTZSCH, 1959) NAKOMAN, 1966 (Pl. III, fig.12).

Groupe: POLLENITES R.POT., 1931

Division: BILATERES PFLUG, 1953

Genre: *MONOCOLPOPOLLENITES* TH. & PF., 1953

Genotype : *Monocolpopollenites tranquillus (R.* POT., 1934) TH. & PF., 1953

Monocolpopollenites areolatus (R. POT., 1934) TH. & PF., 1953 ssp. *areolatus R.* POT., 1934

Monocolpopollenites zievelensis PF., 1953 (Pl. III, fig. 16).

Monocolpopollenites minor KEDVES, 1961

Monocolpopollenites (Palınaepollenites) labiatus BRENNER, 1968 (Pl. III, fig. 15, 17,18,19,20,21,22).

Remarques: Les deux extremites de la *colpa* chez les specimens que nous avons observes, presentent un elargissement elliptique. D'autre part, ils sont un peu plus grands que les formes presentees par G. J. Brenner.

Division: INAPERTURES TH. & PF, 1953

Genre: *INAPERTUROPOLLENITES PF.* & TH, 1953

Genotype: *Inaperturopollenites dubius (R.POT.* & VEN., 1934) TH. & PF., 1953

Section: Magnoidae PF., 1953

Inaperturopollenites dubius (R. POT. & YEN, 1934) TH. & PF., 1953 (Pl. III, fig. 23, 24, 25,31).

Division: BREVAXONES PFLUG, 1953

Genre : *TRIATRIOPOLLENITES PF.*, 1953

Genotype : *Triatriopollenites rurensis PF.,* & TH, 1953

Section : Anuloferoidae PF. 1953

Triatriopollemtes excelsus (R.POT., 1934) TH. & PF, 1953 ssp. *typicus PF.,* 1953 (Pl. III, fig. 27,30).

Triatriopollenites excelsus (R. POT., 1934) TH. & PF., 1953 ssp. *minor PF.,* 1953 (Pl. III, fig. 26,28,29,32,33).

Section: Labraferoidae PF., 1953

Triatriopollenites pseudorurensis PF., 1953 (Pl. III, fig. 37).

Triatriopollenites rurensis pp. & TH., 1953

Triatriopollenites rurobituitus PF., 1953 (Pl. III, fig. 35,36,40,41,42,43,44,45).

Triatriopollenites bituitus (R.POT., 1931) TH. & PF., 1953 (Pl. III, fig. 34,38,39,46).

Section: Alabroidae PF., 1953

Triatriopollenites coryphaeus (R. POT., 1931) TH. & PF., 1953 ssp. *microcoryphaeus* (R. POT., 1931) TH. & PF., 1953 (Pl. III, fig. 47).

Triatriopollenites plicatus (R. POT., 1934) TH. & PF., 1953 (Pl. III, fig. 48,49).

Genre: *TRIPOROPOLLENITES PF.* & TH., 1953

Genotype: *Triporopollenites coryloides PF.,* 1953

Triporopollenites labraferus (R: POT, 1934) TH. & PF, 1953 (Pl. III, fig. 50,51,52).

Genre: *SUBTRIPOROPOLLENITES PF.* & TH., 1953

Genotype: *Subtriporopolltnites anulatns PF.* & TH, 1953

Subtriporopollenites anulatus PF. & TH., 1953 ssp. *nanus* pp. & TH., 1953 (Pl. III, fig. 53,54).

Subtriporopollenites constans PF., 1953 (Pl. III, fig. 55,56,57,58,59,60).

Subtriporopollenites intraconstans pp, 1953 (Pl. III, fig. 61,62,63,64,65,66).

Subtriporopollenites rariechinatus nov. sp. (Pl. III, fig. 67).

Holotype: Pl. III, fig. 67.

Diagnose: Pollens subtriporates de petite taille. Exine ornee d'epines lächement reparties. Forme generale triangulaire fortement convexe.

Description: La forme de ces pollens subtriporates est triangulaire. Les cotes du triangle sont fortement convexe. Ils ont une petite taille (holotype: 17 microns). Leur exine est couverte d'epines, de disposition lache.

Comparaison: Voir *S. densiechinatus* nov. sp.

Origine: Karakaya, echantillon 2424.

Subtriporopollenites densiechinatus nov. sp. Pl. III, fig. 68,69,70,71,72,73,74,75,76 et Pl. IV, fig. 1,2.

Holotype: Pl. III, fig. 70.

Diagnose: Pollens subtriporates de petite taille. Exine ornee d'epines de disposition serree. Forme generale, triangulaire tres convexe.

Description: La forme de ces pollens subtriporates est triangulaire. Les cotes du triangle sont tres convexe. Ça leur donne une allure circulaire. Ils ont une petite taille (holotype: 18 microns), variant entre 13 et 20 microns. Leur exine est couverte d'epines, de disposition serree.

Comparaison: S. *densiechinatus* nov. sp. et *S, rariechinatus* nov. sp. sontles deux especes de ce genre, portant des epines. La disposition de celles-ci est serree sur la preraiere et lache sur la seconde.

Origine: Karakaya, echantillon 2424.

Genre: *POLYVESTIBULOPOLLENITES PF.,* 1953

Genotype: *Polyvestibulopollenites verus (R.* POT., 1934) TH. & PF., 1953

Polyvestibulopollenites verus (R.POT., 1934) TH. & PF., 1953

Genre: *POROCOLPOPOLLENITES PF.,* 1953

Genotype: *Porocolpopolknites vestibuloformis* PF., 1953

Section: Rotundoidae PF., 1953

Porocolpopollenites cf. *rotundus (R. POT.,* 1931) TH. & PF., *1953f. rotundus (R.* POT., 1931) TH. & PF., 1953 (Pl. IV, fig. 3).

Porocolpopollenites cf. *rotundus (R.* POT., 1931) TH. & PF., 1953 f. *projectus PF.,* 1953 (Pl. IV, fig. 4).

Division: LONGAXONES PFLUG, 1953

Genre: *TRICOLPOPOLLENITES PF.* & TH., 1953

Genotype: *Tricolpopollenites parmularius (R.POT.* 1934) TH. & PF., 1953

Section: Asperoidae PF., 1953

Tricolpopollenites henrici (R.POT., 1931) TH. &PF., 1953 (Pl. IV, fig. 15,16,17,18,19).

Tricolpopollenites asper PF. & TH., 1953 (Pl. IV, fig. 20,21).

Tricolpopollenites densus PF., 1953 (Pl. IV, fig. 26,27,28,29,30,31,35,36,37,38).

Tricolpopollenites microhenrici (R. POT., 1931) TH. & PF., 1953 ssp. *intragranulatus PF.,* 1953 (Pl. IV, fig. 22,23,24,25).

Tricolpopollenites liblarensis (TH., 1950) TH. & PF., 1953 ssp. *liblarensis (TH.,* 1950) TH. & PF., 1953 (Pl. IV, fig. 32).

Tricolpopollenites liblarensis (TH., 1950) TH. & PF., 1953 ssp. *fallax* **(R.** POT., 1934) TH. & PF., 1953 (Pl. IV, fig. 33,34).

Tricolpopollenites retiformis PF. & TH., 1953 (Pl. IV, fig. 41).

Tricolpopollenites pseudoeuphorii PF., 1953 (Pl. IV, fig. 40).

Genre: *TRICOLPITES* (ERDTMAN, 1947; COOKSON, 1947) COUPER, 1953

Lectogenotype: *Tricotpites reticulatus* COOKSON, 1947

Tricolpites levis SAH & DUTTA, 1966 (Pl. IV, fig. 7,8,9).

Tricolpites longicolpus SAH & DUTTA, 1966 (Pl. IV, fig. 13,14).

Genre: *TR1COLPOROPOLLEN1TES PF.* & TH., 1953.

Génotype: *Tricolporopollenites dolium (R.* POT., 1931) TH. & PF., 1953

Section: Longoporoidae pp., 1953

Tricolporopollenites villensis (TH., 1950) TH. & PP., 1953 (Pl. IV, fig. 52).

Tricalporopollenites cingulum (R. POT., 1931) TH. & PF., 1953 ssp. *pusillus (R.* POT., 1931) TH. & PF., 1953 (PI. IV, fig. 46).

Tricolporopollenites cingulum (R. POT., 1931) TH. & PF., 1953 ssp. *oviformis (R.* POT., 1931) TH. & PF., 1953 (PI. IV, fig. 45,47,48).

Tricolporopollenites megaexactus (R. POT., 1931) TH. & PF., 1953 ssp. *brühlensis* (TH., 1950) TH. & PF., 1953 (PI. IV, fig. 43,44,49,50,51).

Section: Orbiporoidae PF., 1953

Tricolporopollenites kruschi (R. POT., 1931) TH. & PF., 1953 ssp. *analepticus (R.* POT., 1931) TH. & PF., 1953 (PI. IV, fig. 58).

Tricolporopollenites kruschi (R. POT., 1931) TH. & PF., 1953 ssp. *contortus PF.,* & TH., 1953 (Pl. IV, fig. 59).

Tricolporopollenites kruschi (R. POT., 1931) TH. & PF., 1953 ssp. *pseudolaesus* (R.POT., 1931) TH.&PF., 1953 (Pl. lV,fig. 53).

Section: Microporoidae PF., 1953

Tricolporopollenites microreticulatus PF. & TH., 1953 f. *globosa PF.* & TH., 1953 (PI. IV, fig. 54).

Section: Clavoferae PF. & TH., 1953

Tricolporopollenites microiliacus PF. & TH., 1953 (Pl. IV, fig. 55,56).

Tricolporopollenites margaritatus (R. POT., 1931) TH. & PF., 1953 ssp. *minor PF.* & TH., 1953 (Pl. IV, fig. 57).

Genre: *TETRACOLPOROPOLLENITES PF.* & TH., 1953

Génotype: *Tetracolporopollenites sapotoides PF.* & TH., 1953

Section: Obscuroidae PF. & TH., 1953

Tetracolporopollenites abditus pp., 1953 (PI. IV, fig. 60).

Section: Manifestoidae PF. & TH., 1953

Tetracolporopollenites microrhombus PF., 1953 (Pl. IV, fig. 61,62).

Tetracolporopollenites folliformis PF., 1953 (Pl. IV, fig. 63).

2.2. Remarques sur les résultats qualitatifs et quantitatifs.

Tenant compte des études palynologiques faites sur les lignites tertiaires de la Turquie (Akyol, 1964, 1971; Benda, 1971; Nakoman, 1965, 1966a et *b,* 1967b), nous pouvons donner la liste suivante d'espèces s'éteignant à la fin de l'Eocène (celles marquées de «x» sont trouvées, mais de façon très rare, dans le Stampien de Thracé, Nakoman, 1965, 1966a):

(x) *Punctatosporites paleogenicus* Krutzsch, (x) *Microfoveolatosporis pseudodentatus,* (Krutzsch) Kedves, *Cicatricososporites pseudodorogensis* (R. Pot). Pf., C. *virgatus* Pf., *Punctatisporites parvopunciatus* (Weyl. & Greif.) nov comb., *Undulatisporités brevilaesuratus* Kedves, (x) *Concavisporites arugulatus* Pf., C. *discites* Pf., C. *acutus* Pf., *Echinatisporis erinaceus (Pf.)Krutzsch,* (x) *Hamulàtisporis hamulatis* Krutzsch, (x) *Cicatricosisporties dorogensis* R. Pot. & Gell., *Monocolpopollenites labiatus* Brenner, (x) *Subtriporopollenites constans* Pf., *S. intraconstans* Pf., S. *rariechinatus* nov. sp., S. *densiechinatus* nov. sp., *Tricolpites levis* Sah & Dutta, T. l*ongicolpus* Sah & Dutta.

Les espèces comme *Leiotriletes dorogensis* (Kedves) *Kedves, Monocolpopollenites zievelensis* Pf., *Triatriopollenites excehus* (R. Pot.) Th. & Pf. s'éteignent à la fin de l'Oligocène inférieuret *Laevigatosporites ovatus* Wils. & Webs., X. *discordates* Pf., *Verrucatosporites setundus* R. Pot., V. saalensis Krutzsch, *Toroisporis minons* Nakoman, *Trilites solidus* (R. Pot.) Krutzsch, *T. concavus* Kedves, *Monocolpopollenites areolatus* (R. Pot.) Th. & Pf., *Triporopollenites labraferus (*R. Pot.) Th. & Pf., *Porocolpopollenites rotundus* (R.Pot.) Th. & Pf., *Tricolporopollenites microiliacus* Pf, & Th., *T. margaritatus* (R. Pot.) Th. & Pf., *Tetracolporopollenites abditus* Pf., *T. microrhombus* Pf., *T. folliformis* Pf. à la fin de l'Oligocène. Tandis que *Vetrucatosporites favus* (R. Pot.) Th. & Pf., *V. afavus* Krtitesch, *Leiotriletes ddriennis* (R. Pot. & Gell.) Krutzsch, *L. nominis* Nakoman, *Baculatisporites gemmatus* Krutzsch, *Cingulatisporites vitiosus* (Krutzsch) Nakoman remontent jusqu'à l'Aquitanien.

La prédominance de *Laevigatosporites haardti* (R. Pot. & Ven.) Th. & Pf. se fait remarquer d'une façon générale. Dans le cas où celui-ci possède un pourcentage bas, ce sont *Leiotriletes microadriennis* Krutzsch ou *Cicatricosisporites dorogensis* R. Pot. & Gell. qui prennent sa place. Ces spores Constituent donc, les espèces principales de l'Eocène de Bayat. Il s'y ajoute parfois *Triatriopollenites coryphaeus* (R. Pot.) Th. & Pf. et *Tricolporopollenites cingulum* (R. Pot) Th. & Pf.

La présence quasi-totale de *Monocolpopollenites labiatus* Brenner s'élevant parfois-jusqu'aux 5 %, la quasi-absence des pollens inaperturés et l'absence totale des pollens à ballonnets attirent l'attention.

2.3. Comparaison avec l'Eocène de Sorgun

L'étude palynologique de l'Eocène de Sorgun est réalisée par E. Nakoman (1966b). L'examen des résultats obtenus par l'auteur met au point une conformité nette avec les nôtre. A Sorgun, on observe comme à Bayât:

— Prédominance de spores monolètes *(L. haardti).*

— Prédominance de *Leiotriletes microadrjennis* Krutzsch pu *Cicatritosisporites dorogensis* R. Pot. & Gell. et plus rarement celle de *Triatripollenites coryphaeus* (R. Pot.) Th. & Pf. et *Tricolporopollenites cingulum* (R. Pot.) Th. & Pf., quand le pourcentage de *Laevigatosporites haardti* (R. Pot, & Ven.) Th. & Pf. s'abaisse.

— Présence relative des pollens monocolpés et inaperturés et l'absence totale des pollens à ballonnets.

II existe d'autre part une foulé d'espèce rencontrée à Bayat, mais n'est point présente à Sorgun. Il en est autant quand il s'agit de certaines espèces de Sorgun. Ce sont dés formes de très faible pourcentage dont la présence dans les échantillons est sporadiqué. Nous pouvons lier ce fait à la différence des conditions écologiques pendant la sédimentation des deux régions citées qui amène une exhibition de richesse de la flore éocène.

2.4. Comparaison avec d'asttres bassins Eocenes de la Turquie

Benda (1971) estime qu'a propos de la palynologie de l'Eocene de la Turquie, il est fait peu de chose. Ceci peut etre explique par la paleogeographie du pays au cours de l'Eocene. En effet toute l'Anatolie est sous les eaux de la Tethys pendant l'Ypresien. On observe des emersions en differents points a Lutetien; une zone emergee placee au Nord, s'etale de Merkeşler (Bolu) jusqu'a Çeltek (Amasya), passant par Sorgun (Yozgat), Artova (Tokat) et Kangal (Sivas)[4]. Au Sud, on ne peut denombrer que quelques points isoles. L'Eocene du Sud-Ouest de l'Anatolie etudie par Nakoman (1967a *et b)* caracterise d'apres l'anteur, par la presence des formes comme *Leiotriletes adrieums* (R. Pot. & Gell.) Krutzsch, *L. microadriennis* Krutzsch, *L, dorogensis* (Kedves) Kedves, *Baculatisporites gemmatus* Krutzsch, *Cingulatisporites meurospeciosus* (R. Pot. & Gell.) Nakoman, *Triporopollenites undulatta* Pf., *Intratriparopollenites indutitalis* (R. Pot.) Th. & Pf. et *Tncolporopolenites elongatut* Nakoman. Ce qui est etonnants dans cette liste, c'est l'absence des formes cicatricoses triletes ou monoletes qui constituent les elements principaux de l'Eocene. D'ature part, il faut signaler que l'extensions verticales de *Leiotriletes microadriemis* Krutzsch et *Baculatisporites gemmatus* Krutzsch sont plus larges; la premiere espece remontant jusqu'au Miocene moyen et la seconde, la fin de l'Aquitanien. Les etudes de Nakoman prouvent que *Laevigatesporites haardti* (R. Pot. & Ven.) Th. & Pf., *Triatriopollenites coryphaeus* (R. Pot.) Th. & Pf. et *Tricolporopollenites cingulum* (R. Pot.) Th. & Pf. sont les formes dominantes. C'est un resultat proche de celui obtenu a Bayat.

Pour Benda (1971), ce sont *Concavisporites acutus* Pf., *Triplanosporites tertiarius* Pf., *Laevigatosporites ellipsoideus* Pf., *Compozitoipollenites rizophorus* R. Pot. et *Arecipites zievelensis* (Pf.) R. Pot. qui caracterisent l'Eocene en Turquie. Parmi ces especes *Triplanosporites tertiarius* Pf., *Laevigatosporites (Punctatosporites) ellipsoideus* Pf. et *Compozitoipollenites (Intratriporopollenites) rizophorus* R. Pot. n'existent pas a Bayat. Signalons que *P. ellipsoideus* Pf. remonte d'apres nos remarques jusqti'an meme Pliocene. D'autre part, nos observations exigent des retouches suivantes sur le tableau d'extensions stratigraphiques des formes tertiaires torques donne par Benda (1971, Tableau 1):

D'apres Benda, *Cicatricosisporites dorogensis* R. Pot. & Gell. s'etend jusqu'a la fin du Miocene, *Monocolpopollenites (Arecipites) tranquillus* (R. Pot.) Th. & Pf. et *Tricolporopollenites cingulum* (R. Pot.) Th. & Pf. ssp. *fusus* (R. Pot.) Th. & Pf. la fin du Rupelien et *Inaperturopollenites emmaensis* (Mürr. & Pf.) Th. & Pf. la fin du Pliocene inferieur, *Monocolpopollenites areolatus* (R. Pot.) Th. & Pf. existe dans tout le Tertiaire, *Baculatisporites primarius* (Wolff) Th. & Pf. seulement dans le Miocene, *Tricolporopollenites iliacus* (R. Pot.) Th. & Pf. *(Ilex-type)* et les especes de *Tetradopollenites* Pf. & Th. (Ericales) seulement dans, le Pliocene (Fig. 2). Tandis que pour nous, C. *dorogensis* R. Pot. & Gell. caracterise l'Eocene, *M. tranquillus* (R. Pot.) Th. & Pf. et *T. cingulum fusus* (R. Pot.) Th. & Pf. remontent jusqu'a la fin du Miocene, I. *emmaensis* (Mürr. & Pf.) Th. & Pf. caracterise l'Oligecene, *M. areolatus* (R. Pot.) Th. & Pf. ne se trouve pas au dessus de l'Oligocene, *B. primarius* (Wolff) Th. & Pf. et *Tetrtutopollenites* Pf. & Th. existent des l'Oligocene moyen et *T. iliacus* (R. Pot.) Th. & Pf. dans tout le Tertiaire.

2.5. Comparaison avec quelques etudes l'Eocene d'Europe

Nous devons l'analyses sporo-polliniques des depots du Tertiaire ancien de l'Allemagne aux auteurs Thomson et Pflug (1953). Elles couvrent les couches inferieures de Helmstedt (Ypresien), les couches superieures de Helmstedt (Lutetien) et les couches de Borken (Priabonien+Sannoisien).

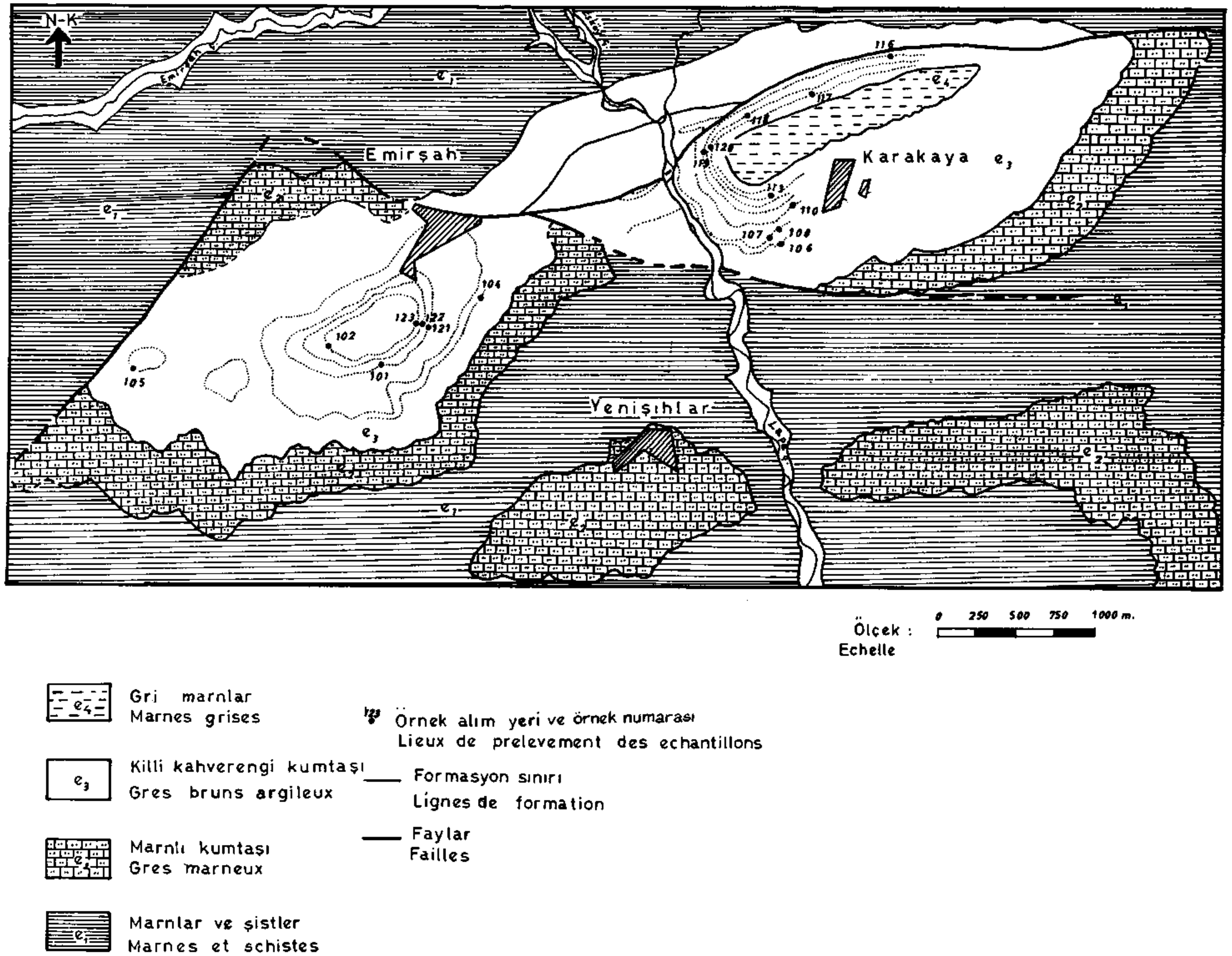

Fig. 1 - Carte géologique de l'environ de Karakaya et Emirşah, et lieux d'échantillonnage (d'après C. Hezarfen).

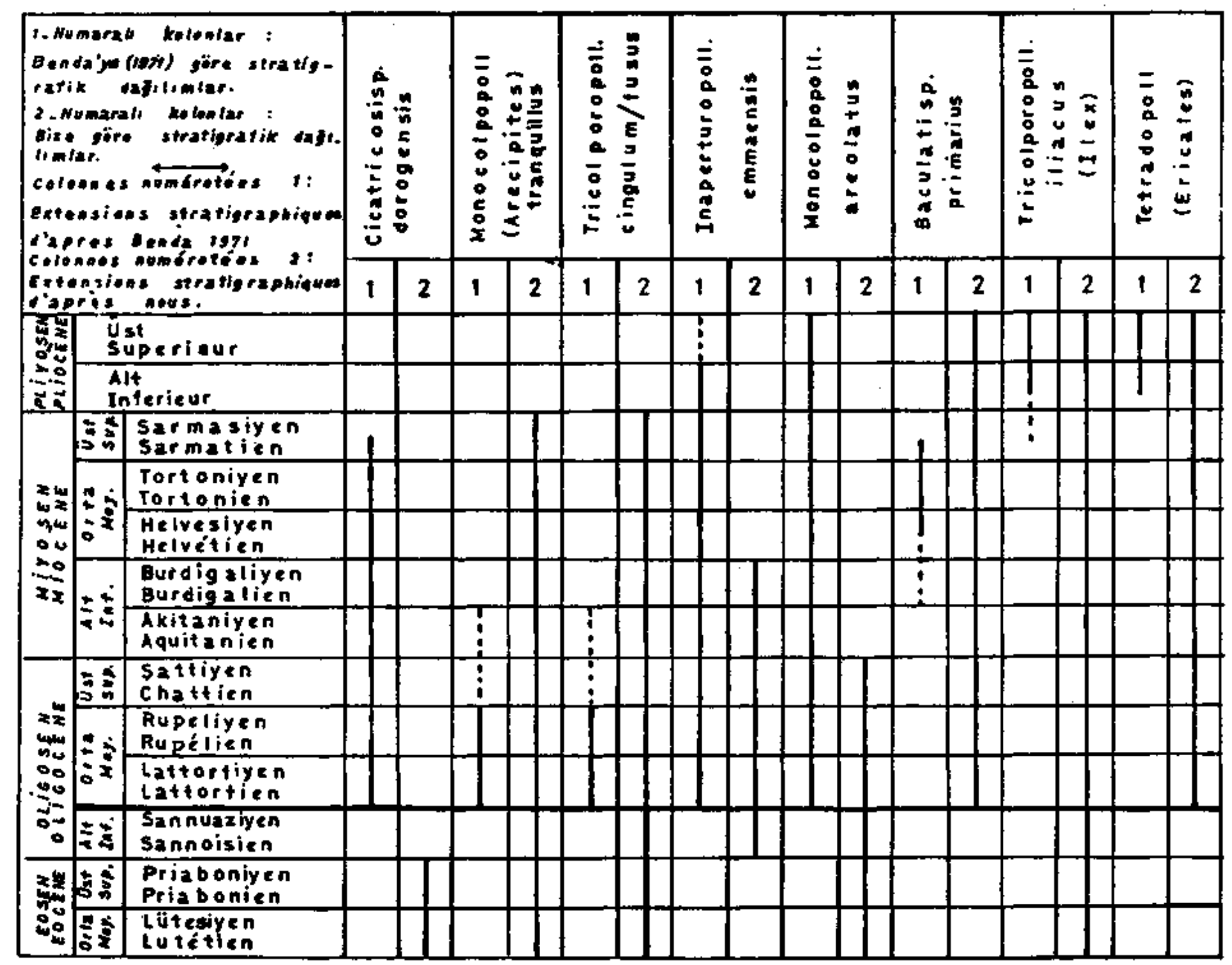

Fig. 2 - Tableau d'extensions stratigraphiques comparatives de quelques formes tertiaires.
• Limite inférieure stratigraphique intéressant les études de Benda (1971).

Leiotriletes adriennis (R. Pot. & Gell.) Krutzsch, *Cicatricososporites pseudodorogensis* (R. Pot.) Pf., C. *virgatus* Pf. et *Triatriopollenites excelsus* (R. Pot.) Th. & Pf. presents dans l'Eocene de Bayat, possedent un fonctionnement stratigraphique semblable en Allemagne. Dans les couches inferieures de Helmstedt on remarque la presence d'une foule d'especes d'*'Extratriporopollenites* Pf. Celles-ci se rarefient dans les couches superieures de Helmstedt. Notons ici, l'absence totale d' *Extratriporopollenites* Pf. a Bayat.

Dans les couches eocenes de Hongrie (Kedves, 1963), *Punctatosporites pahogenicus* Krutzsch, *Undulatisporites brevilaesuratus* Kedves, *Concavisporites arugulatus* Pf., C. *acutus* Pf. *Echinatisporis erinaceus* (Pf.) Krutzsch, *Baculatisporites gemmatus* Krutzsch s'eteignent a la fin du Paleocene, tandis que *Microfoveolatosporis pseudodentatus* (Krutzsch) Kedves a la fin de l'Ypresien et *Verrucatosporites afavus* Krutzsch, *V. saalemis* Krutzsch, *Tetracolporopollenites microrhombus* Pf. a la fin du Lutetien. On observe ainsi l'extinction plus tot de ces especes en Hongrie selon Bayat.

L'analyse sporo-pollinique des formations du Paleogene en France (Durand, 1962), nous offre un certain parallelisme avec celle de Bayat:

Les especes comme *Verrucatosporites secundus* R. Pot., *Cicatricososporites pseudodorogensis* (R. Pot.) Pf., *Leiotriletes adriennis* (R. Pot. & Gell.) Krutzsch, *Cicatricosisporites dorogensis* R. Pot. & Gell. *Triatriopollenites excelsus* (R. Pot.) Th. & Pf. ont les memes extension stratigraphiques. Quant aux differences entre les extensions verticales des especes comme *Laevigatosporites discordatus* Pf., *Trilites solidus* (R. Pot.) Krutzsch, *Monocolpopollenites zienelensis* Pf. et *Subtriporopollenites constans* Pf., elles sont d'ordre a qualifier semblables. Remarquons qu'en France aussi, les especes *d'Extratriporopollenites* Pf. s'eteignent ä la fin de l'Ypresien.

2.6. Conclusions generales

Il n'existe en Turquie aucune etude palynologique sur ni le Cretace, ni le Paleocene. Parce que les formations cretacees et paleocenes sont marines. Parmi elles, on n'a pu decouvrir jusqu' ä present, un niveau privilegie dans lequel aborderaient des spores et des pollens. Cest ainsi qu'on n'a pas encore rencontre en Turquie de *Normapolles* qui sont les elements essentiels du Cretace, du Paleocene et meme de l'Ypresien (Krutzsch, 1966). Les lignites de Bayat ne contiennent pas de *Normapolles.* Ajoutant ä ce fait l'existence des formes eocenes, il faut considerer ces charbons d'äge lutetien ou priabonien. La palynologie ne nous offre pas d'indice pour faire un choix formel entre le Lutetien et le Priabonien. Cest la qu'il faut faire intervenir les etudes de A. Güngör qui, par la determination des fossiles dejä cites (p. 39), attribue les Sediments contenant les lignites (e3) au Lutetien.

L'existence de *Normapolles* en Turquie n'est pas signalee non plus par les autres auteurs (Benda, 1971; Nakoman, 1966b, 1967a et *V)*. Malgre ceci, Nakoman considere les lignites de Sorgun de l'äge Ypresien-(1966b, p. 69). Il s'appuie sur la liste de foraminiferes determines par Pekmen. Mais ceux-ci indiqueraient le Lutetien d'apres Meriç[5]. Vus les points palynologiques analogues entre Sorgun et Bayat, l'age Ypresien n'est pas acceptable pour les charbons de Sorgun. Ils doivent dater du Lutetien comme ceux de Bayat.

3. ESSAI DE CORRELATION ENTRE LES VEINULES DE KARAKAYA ET EMİRŞAH

Le bassin de Bayat est constitue de deux bassins plus petits; Karakaya et Emirşah (Fig. **1).** Tous les deux portent des caracteres paraliques.

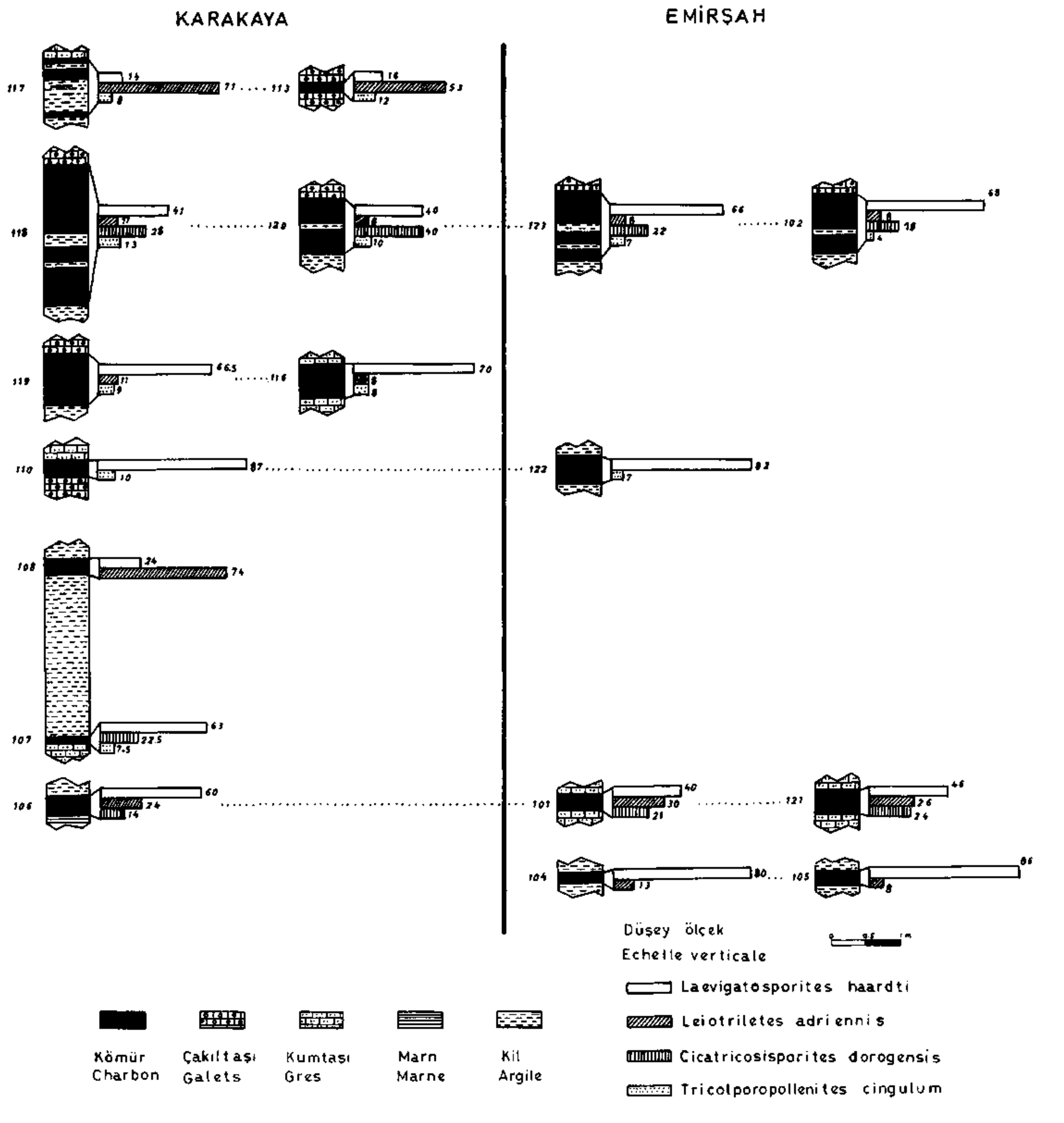

Fig. 3 - Tableau de corrélation des veines de charbon de Karakaya et Emirşah.

Le bassin de Karakaya qui est plus important que celui d'Emirşah, se presente sous forme d'un petit synclinal (Photo 1). Le village Karakaya se trouve au versant sud-est d'une colline ou les lignes du synclinal sont bien visibles. On y decele sept niveaux ligniteux intercales de Sediments aux caracteres marins dont les six premiers ont ete l'objet d'etude. Le nombre des veinules diminue dans le synclinal d'Emirşah. Parmi elles, seules les quatre sont etudiees.

Les resultats statistiques obtenus sont reportes sur la Figure 3. Comme l'on voit bien sur ce tableau, les niveaux etudies de Karakaya et d'Emirşah sont parfaitement correlables. La Sedimentation charbonneuse a ete commencee d'abord a Emirşah (ech. 104 et 105), mais a cause de l'instabilite des fonds des lagunes, n'y a pas ete aussi continue qu'a Karakaya. Ainsi elle a ete plus tardive dans le bassin de Karakaya (ech. 117 et 113).

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P L A N C H E S

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Toutes les photos sont au grossissement X 500

PLANCHE - I

Fig. 1,2,3,4,5,6,7 - *Laevigatosporites haardti* (R. Pot. & Ven.) Th. & Pf.

Fig. 8,9,10,11,12,15,16,17 - *Laevigatosporites discordatus* Pf.

Fig. 13,14,18,19,20 - *Laevigatosporites ovatus* Wils. & Wehs.

Fig. 21,22,23 - *Punctatosporites paleogenicus* Krutzsch

Fig. 24,25,26 - V*errucatosporites Javus* (R. Pot.) Th. & Pf.

Fig. 27,28,29,30,31 - *Verrucatosporites alavus* Krutzsch

Fig. 32,33,34,35,36,37,38,39,40 - V*errucatosporites secundus* (R. Pot.) Krutzsch

Fig. 41,42,43,44,45,46 - V*errucatusporites saalensis* Krutzsch

Fig. 47,49,50,51 - *Microfoveolatosporis pseudodentatus* (Krutzsch) Kedves

Fig. 48 - *Microfoveolatosporis* sp.

Fig. 52 - *Cicatricososporites* sp.

Fig. 53 - *Cicatricososporites pseudodorogensis* (R. Pot). Pf.

Fig. 54,55,58 - *Cicatricososporites virgatus* Pf.

Fig. 56,57 - *Microfoveolatosporis bayatensis* nov. sp.

PLANCHE - II

Fig. 1,2 - Le*iotriletes adriennis* (R. Pot. & Gell.) Krutzsch

Fig. 3.4,5,6,7,8,9,10 - *Leiotriletes microadriennis* Krutzsch

Fig. 11,12,13,14,23,38 - *Leiotriletes dorogensis* (Kedves) Kedves

Fig. 15,17 - *Punctatisporites parropunctatus* (Weyl. & Greif.) nov. comb.

Fig. 16 - *Leiotriletes nominis* Nakoman

Fig. 18,26,27,28,29- *Concavisporites arugulatus* Pf.

Fig. 19,20,21,34- *Punctatisporites aquisgranensis* Weyl. &: Krieger

Fig. 22- *Punctatisporites* sp.

Fig. 24,25- *Undulatisporitta brevilaesuratus* Kedves

Fig. 30- *Concavisporites discitts* Pf.

Fig. 31- *Concavisporites acutus* Pf.

Fig. 32,33- *Toroisporis minoris* Nakoman

Fig. 35,36- *Trilites concavus* Kedves

Fig. 37- *Echinatisporis erinaceus* (Pf.) Krutzsch

Fig. 39 - *Trilites solidus* (R. Pot.) Krutzsch

Fig. 40,42 - *Trilites* sp.

Fig. 41 - Ec*hinatisporis minutus* nov. sp.

Fig. 43,44 - *Baculatisporites primarius* (Wolff) Th. & Pf.

Fig. 45 - *Baculatisporites gemmatus* Krutzsch

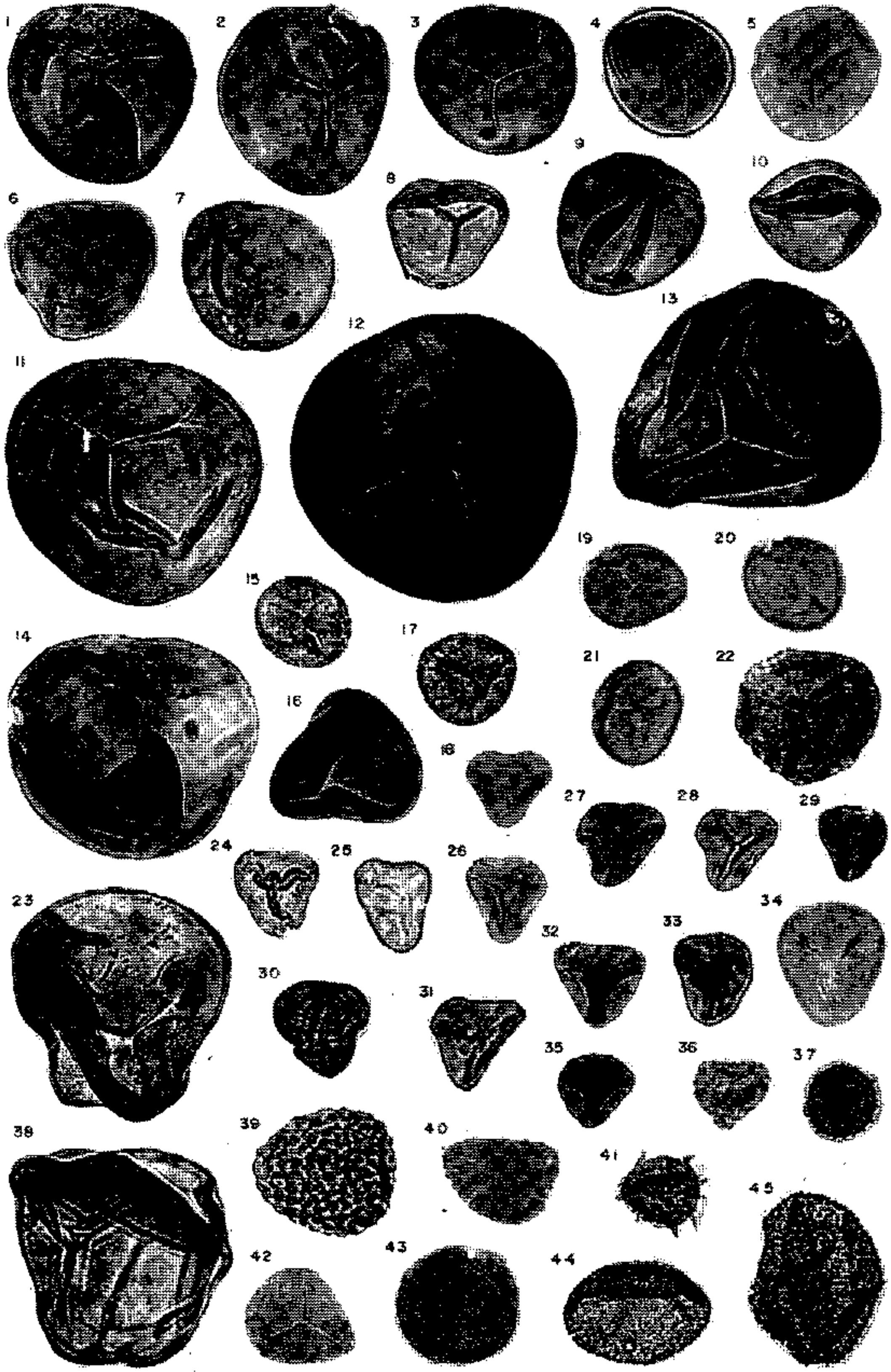
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PLANCHE - III

Fig. 1 - *Baculatisporites primanus* (WolfT) Th. & Pf.

Fig. 2,3,4,5,6,7,8,9,10,11 - *Cicatricosisporites dorogensis* R. Pot & Gell.

Fig. 12 - *Cingulatisporites ritiosus* (Krutzsch) Nakoman

Fig. 13,14 - *Hamulatisporis hamulatis* Krutzsch

Fig. 15,17,18,19,20,21,22 - *Monocolpopollenites (Palmaepollenites) labiatus* Brenner

Fig. 16 - *Monocolpopollenites, zievelensis* Pf.

Fig. 23,24,25,31 - *Inaperturopollenites dubius* (R. Pot. & Ven.) Th. & Pf.

Fig. 26,28,29,32,33 - *Triatriopollenites excelsus* (R. Pot.) Th. & Pf. ssp. minor Pf.

Fig. 27,30 - *Triatriopollenites excelsus* (R. Pot.) Th. & Pf. ssp. *typicus* Pf.

Fig. 34,38,39,46 - *Triatriopollenites bituttus* (R. Pot.) Th. & Pf.

Fig. 35,36,40,41,42,43,44,45 - *Triatriopollenites rurobituitus* Pf.

Fig. 37 - *Triatriopollenites pseudorurensis* Pf.

Fig. 47 - *Triatriopollenites coryphaeus* ssp. *microcoryphaeas* (R. Pot.) Th. & Pf.

Fig. 48,49 - *Triatriopollenites plicatus* (R. Pot.) Th. & Pf.

Fig. 50,51,52 - *Triporopollenites labraferus* (R. Pot.) Th. & Pf.

Fig. 53,54 - *Subtriporopollenites anulatus* ssp. *nanus* Pf. & Th.

Fig. 55,56,57,58,59,60 - *Subtriporopollenites cunstans* Pf.

Fig. 61,62,63,64,65,66 - *Subtriporopollenites intracomtans* Pf.

Fig. 67 - *Subtriporopollenites rarirehinalus* nov. sp.

Fig. 68,69,70,71,72,73,74,75,76 - *Subtriporopollenites densiechinatus* nov. sp.

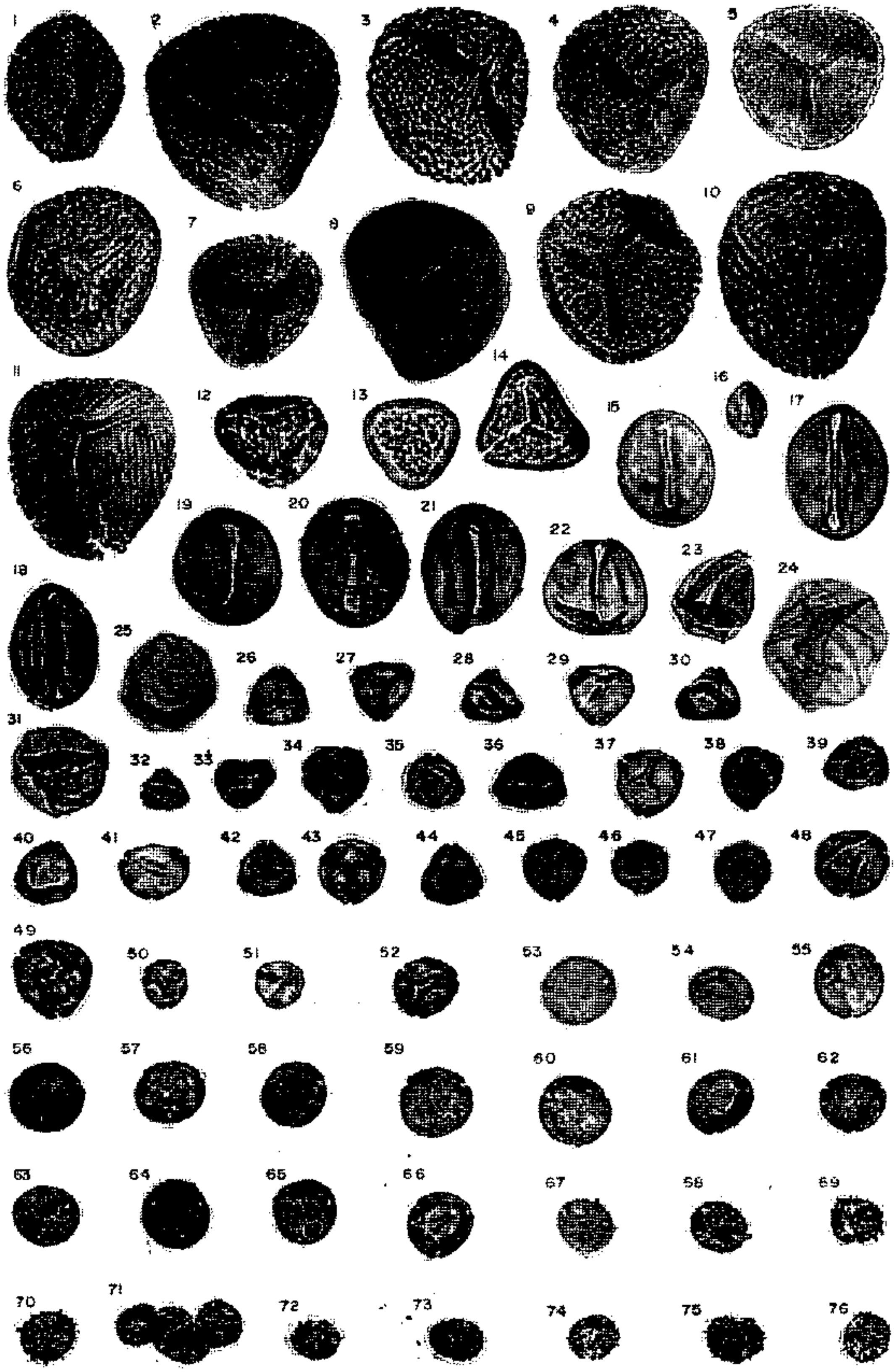

PLANCHE - IV

Fig. 1,2 - *Subtriporopollenites densiechinatus* nov. sp.

Fig. 3 - *Porocolpopollenites* cf. *rotundas* f. *rotundas* (R. Pot.) Th. & Pf.

Fig. 4 - *Porncolpopollenites* cf. *rotundas* (R. Pot.) Th. & Pf. f. *projectus* Pf.

Fig. 5,6 - *Tricolpopollenites* sp.

Fig. 7,8,9 - *Tricolpites levis* Sah & Dutta

Fig. 10,11,12 - *Triculpites* sp.

Fig. 13,14 - *Tricolpites longicolpus* Sah & Dutta

Fig. 15,16,17,18,19 - *Tricolpopollenites henrici* (R. Pot.) Th. & Pf.

Fig. 20,21 - *Tricolpopollenites asper* Pf. & Th.

Fig. 22,23,24,25 - *Tricolpopollenites microhenrici* (R. Pot.) Th. & Pf. ssp. *intragranulatus* Pf.

Fig. 26,27,28,29,30,31,35,36,37,38 - *Tricolpopollenites densus* Pf.

Fig. 32 - *Tricolpopollenites, liblarensis* ssp. *liblarensis* (Th.) Th. & Pf.

Fig. 33,34 - *Tricolpopllenites libtarensis* (Th.) Th & Pf. ssp. *fallax* (R. Pot.) Th. & Pf.

Fig. 39 - *Disulcites* sp.

Fig. 40 - *Tricolpopollenites pseudoeuphorii* Pf.

Fig. 41 - *Tricolpopollenites retiformis* Pf. & Th.

Fig. 42 - *Tricolpopollenites* sp.

Fig. 43,44,49,50,51 - *Tricolporopollenites megaexactus* (R. Pot). Th. & Pf. ssp. *brühlensis* (Th.) Th. & Pf.

Fig. 45,47,48 - *Tricolporopollenites cingulum* ssp. *oviformis* (R. Pot.) Th. & Pf.

Fig. 46 - *Tricolporopollenites cingulum* ssp. *pusillus* (R. Pot.) Th. & Pf.

Fig. 52 - *Tricolporopollenites villensis* (Th.) Th. & Pf.

Fig. 53 - *Tricolporopollenites kruschi* ssp. *pseudolaesus* (R. Pot.) Th. & Pf.

Fig. 54 - *Tricolporopollenites microreticulatus* Pf. & Th. f. *globosa* Pf.

Fig. 55,56 - *Tricolporopullenites microiliacus* Pf. & Th.

Fig. 57 - *Tricolporopollenites margaritatus* (R. Pot.) Th. & Pf.

Fig. 58 - *Tricolporopollenites kruschi* ssp. *analepticus* (R. Pot.) Th. & Pf.

Fig. 59 - *Tricolporopollenites kruschi* (R. Pot.) Th. & Pf. ssp. *contortus* Pf. & Th.

Fig. 60 - *Tetracolporopollenites abditus* Pf.

Fig. 61,62 - *Tetracolporopollenites microrhombus* Pf.

Fig. 63 - *Tetracolporopollenites folliformis* Pf.

Fig. 64 - *Tetracolporopollenites* sp.

Fig. 65 - Spore trilete indeterminee.

Fig. 66,67,68,69,70 - Organismes indetermines.

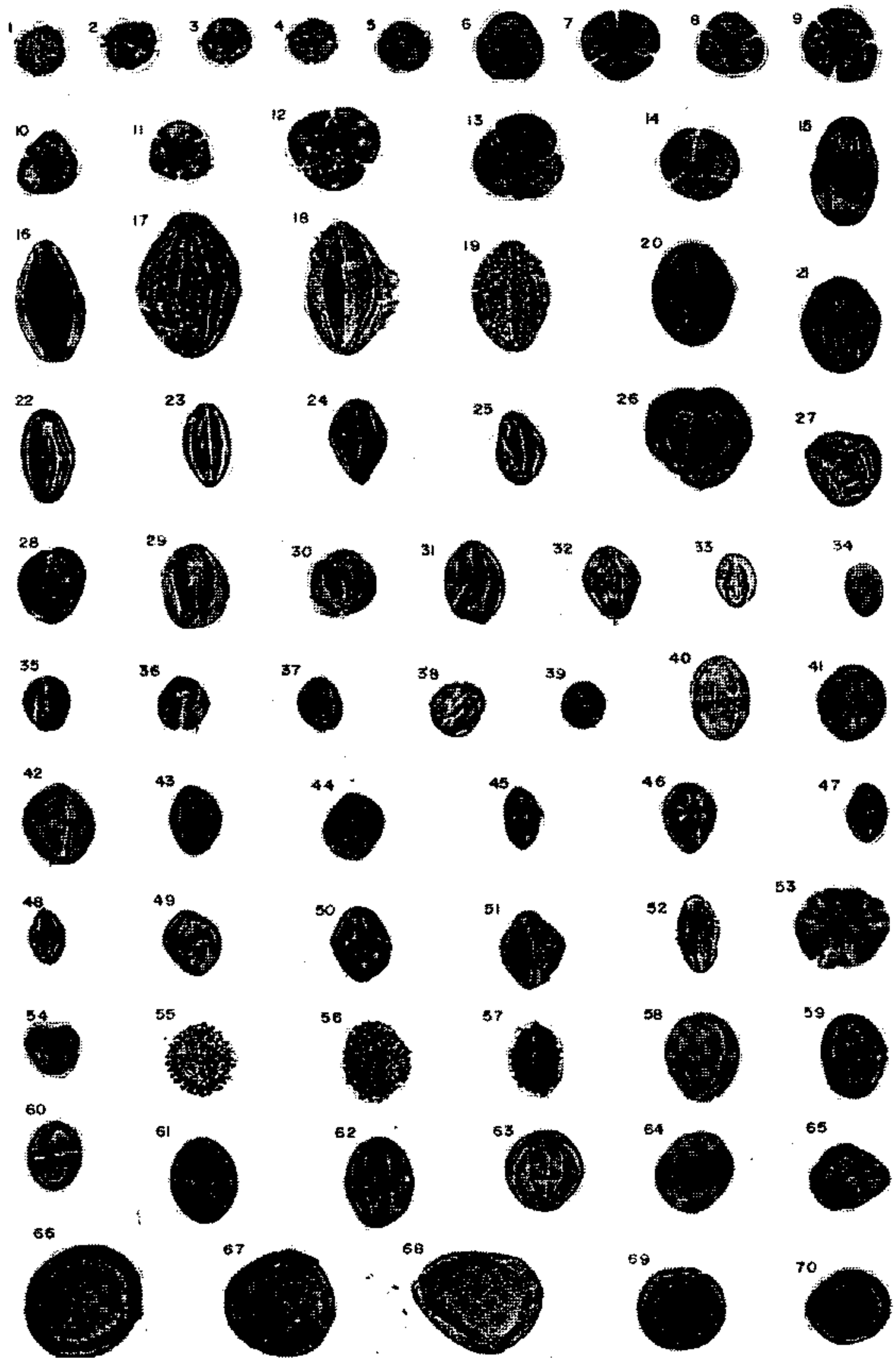
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Photo 1 - Vue d'Ouest du Synclinal de Karakaya.

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QUELQUES FORMES SPORO-POLLINIQUES CARACTERISTIQUES DE LA MICROFLORE D'ÜZÜLMEZ (BASSIN HOUILLER DU NORD-OUEST DE L'ANATOLIE-TURQUIE)

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SOMMAIRE. — Dans le cadre de ce travail, en se basant sur les resultats des etudes palynologiques des 132 echantillons provenant de 7 galeries du secteur d'Üzülmez du bassin houillcr du Nord-Ouest de l'Anatolie, on a pu determiner les spores et pollen semblant ctre caracteristiques de la microflore du Namurien et du Westphalien A du secteur precite.

1. GEOLOGIE SOMMAIRE DU BASSIN HOUILLER DU NORD-OUEST DE L'ANATOLIE

Le bassin houiller du Nord-Ouest de l'Anatolie est constitue par de nombreux affleurements qui s'etent d'Ereğli jusqu'a Söğütözü (Fig. 1). Les principaux affleurements sont de Çamlı, Kandilli, Alacaağzı, Kireçlik, Kozlu-Zonguldak, Kilimli, Karadon, Göbü, Amasra, Pelitovası, Kırmacı, Azdavay, Kozluviran et de Söğütözü.

La succession stratigraphique de ce bassin peut etre resumee de la maniere suivante (de la base vers le sommet):

— Le calcaire carbonifere: Il s'agit d'une formation calcareuse qui surmonte en concordance le Devonien au Sud-Est d'Ereğli et a l'Est dans la region de Bartın, se termine par des couches de dolomites, de calcaires, de phtanites et de schistes noirs attribues au Viseen superieur.

— Serie d'Alacaağzı (Namurien A, B et C): Cette serie ayant une epaisseur qui peut atteindre par endroit 500 m est constitute par des schistes argileux contenant des intercalations greseuses; sa partie inferieure est tres schisteuse, presque sterile, et ne comporte que quelques veinules de charbon. Par contre, sa partie superieure est nettement plus greseuse et possede 16 veines de charbon principales dont l'epaisseur totale peut atteindre 16 m.

— Serie de Kozlu (Westphalien A): Cette serie est formee par des gres, des conglomerats et des gres conglomeratiques. Elle ne contient que tres peu de schistes argileux. C'est la serie la plus importante tant par son epaisseur (environ de 1000 m) que par le nombre des veines qu'elle contient. Elle renferme, en effet, 22 veines principales ayant une epaisseur totale de houille de 35,5 m.

— Serie de Karadon (Westphalien B (?), C et D): C'est une serie qui est constitute par des conglomerats gris-verdatre a ciment calcareux et des gres. Son epaisseur est environ de 400 m. Le nombre des veines qu'elle contient n'est pas bien connu. D'apres de nombreux auteurs, il y aurait, dans la serie de Karadon 8 veines de charbon totalisant une epaisseur nette de 10 m.

— Les terrains dits«de couverture»: Ces formations debutent par un conglomerat de base ayant une epaisseur de 10 a 50 m. Sur cette formation se reposent, le calcaire barremien, la serie d'İncüvez (Aptien inferieur), les gres de Velibey (Aptien superieur), la serie des gres verts d'age Albien inferieur et moyen, les marnes bleues argileuses d'Albien superieur et enfin le flysch cenomanien.

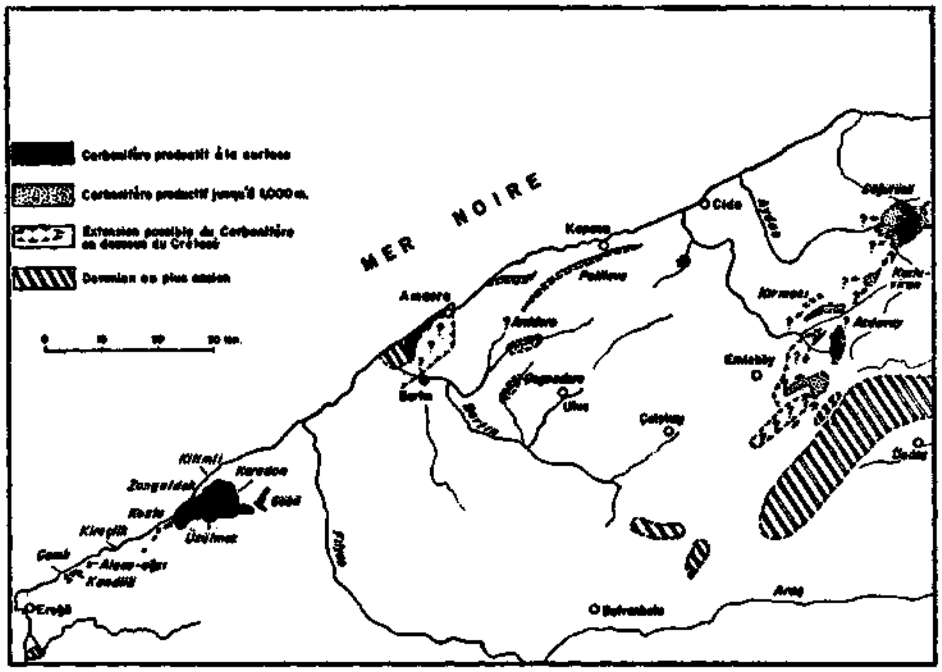

Fig. 1 - Bassins carbonifères du Nord-Ouest de l'Anatolie.

2. ETUDES PALYNOLOGIQUES

Afin de pouvoir etablir les spores et pollen caracteristiques du Namurien et du Westphalien A du secteur d'Üzülmez du bassin houiller du Nord-Ouest de l'Anatolie, nous avons entrepris de nouveau l'examen sporo-pollinique qualitatif des 132 prelevements de houille provenant des 7 galeries du secteur precite. Ces echantillons cites ci-haut ont ete etudie auparavant afin de pouvoir dresser les spectres palynologiques des veines Agop I, Agop II, Papas, Kesmeli, İstefan, Küçük, Büyük, Küçük no. 1, Küçük no. 2, Karamanyan, Unudulmuş, Domuzcu, Taşbaca, Acenta, Milopero, Neomi, Hacımemiş, Sulu, Leonidas, Küçük no. 5, Ömerağa, Civelek, Sülman, Topuz et Büyük Kılıç.

a. Formes sporo-polliniques caracteristiques de la microflore Namurienne d'Üzülmez

Les genres de forme semblant caracteriser la microflore d'age Namurien sont *Rotaspora* (Sch.) Ağr., *Procoronaspora* Butt. & Will., *Nevesisporites* Nak., *Yahşımanisporites* Ağr., *Tripartites* Sch., *Pekmezcileripollenites* Ağr., *Perisaccus* (Naum.) Naum. et *Velosporites* Haugh. & Play.

Il faut egalement signaler que *Nevesisporites* Nak. et *Procoronaspora* Butt. & Will, semblent caracteriser le Namurien inferieur. Alors que *Yahşımanisporites* Ağr. et *Pekmezcileripollenites* Ağr. ne se rencontrent que dans la microflore des niveaux d'age Namurien moyen.

Les especes principales des genres de forme signales ci-haut sont: *Rotaspora knoxi* Butt. & Will. (PI. II, fig. 11), *Rotaspora obtusus* (Naum.) Ağr. (PI. II, fig. 12, 13), *Rotaspora annellitus* (Horst) Pot. & Kr. (PI. II, fig. 14), *Rotaspora horsti* Nak. (Pl. II, fig. 15), *Procoronaspora ambigua* Butt. & Will. (Pl. II, fig. 16), *Procoronaspora rarigranulata* Ağr. (Pl. II, fig. 17), *Procoronaspora tenuigranulata* Nak. (Pl. II, fig. 18), *Nevesisporites tribullatus* Nak. (PI. II, fig. 19), *Yah-*

şımanisporites batillatus (Haugh. & Play.) Ağr. (PI. II, fig. 23), *Yahşımanisporites subbransonii* Ağr. (Pl. II, fig. 24), *Tripartites primitive* Ağr. (Pl. II, fig. 26), *Tripartites vetustus* Sch. (Pl. II, fig. 27), *Tripartites annosus* (Isch.) Sull. & Nev. (PI. II, fig.28), *Tripartites simplicissimus* Dyb. & Jach. (PL II, fig. 29), *Tripartites ianthinus* Butt. & Will. (Pl. II, fig. 30), *Tripartites granulatus* Ağr. (Pl. II, fig. 31), *Tripartites auritus* (Isch.) Ağr. (Pl. II, fig. 32), *Tripartites, vermiculatus* Ağr. (PI. II, fig. 33), *Tripartitee cassiformis* (Isch.) Nak. (PI. II, fig. 34), *Tripartites parvus* (Isch.) Ağr. (Pl. II, fig. 35), *Tripartites cristatus* Dyb. & Jach. (Pl. II, fig. 36), *Tripartites trifoliatus* Dyb. & Jach. (Pl. II, fig. 37), *Tripartites variahilis* (Isch.) Ağr. (Pl. II, fig. 38), *Tripartites aducttis* (Isch.) Sull. & Nev. (PI. II, fig. 39), *Tripartites regularis* Nak. (PI. II, fig. 40), *Tripartites turbidus* Nak. (PI. Ill, fig. 1), *Tripartites obtusus* Nak. (PI. III, fig. 2). *Pekmezcileripollenites medianamurensis* (PI. Ill, fig. 4, 5) et *Perisaccus oblongus* Ağr. (PI. III, fig. 6).

En outre, les especes suivantes appartenant aux genres de forme dont l'extension verticale est tres large, semblent caracteriser la microflore namurienne: *Punctatisporites minutus* Kos. (PI. I, fig. 1), *Punctatisporites nudus* Art. (PI. I, fig. 2), *Punctatisporites mundus* Kos. (PI. I, fig. 3), *Punctatisporites amasrensis* Ağr. (PI. I, fig. 4), *Punctatisporites asperatus* (Lub.) Aky. (PI. I, fig. 5), *Punctatisporites bacatus* Nak. (Pl. I, fig. 7), *Punctatisporites üzülmezensis* Nak. (Pl. I, fig. 6), *Pachytriletes perfectus* Nak. (PI. I, fig. 8), *Calamospora coronata* Ağr. (Pl. I, fig. 9), *Granulatisporites rudigranulatus* Stap. (Pl. I, fig. 10), *Granulatisporites trilobotorosus* Nak. (PI. I, fig. 11), *Verrucosisporites rufus* Butt. & Will. (PI. I, fig. 12), *Verrucosisporites kari* Nak. (Pl. I, fig. 13), *Verrucosisporites irregularis* Nak. (PI. I, fig. 14),.*Convolutispora mira* Nak. (Pl. I, fig. 15), *Lophotriletes perfectus* Nak. (Pl. I, fig. 16), *Lophotriletes moderatus* Nak. (Pl. I, fig. 17), *Acanthotriletes castaneus* Butt. & Will. (Pl. I, fig. 18), *Acanthotriletes ciliatus* (Knox) Pot. & Kr. (Pl. I, fig. 19), *Horriditriletes grandis* Nak. (PI. I, fig. 20), *Horriditriletes rudis* Nak. (PI. I, fig. 21), *Camptotriletes jansoniusi* Nak. (Pl. I, fig. 22), *Egemenisporites vermiformis* (Haugh. & Play.) Ağr. (Pl. I, fig. 23, 24), *Dictyotriletes minor* Naum. (Pl. I, fig. 28), *Reticulatisporites waltzi* Ağr. (Pl. I, fig. 26), *Reticulatisporites punctatus* Nak. (Pl. I, fig. 25), *Reticulatisporites largus* Nak. (PI. I, fig. 27), *Reticulatisporites baykali* Nak. (PI. II, fig. 1), *Knoxisporites altınlıi* Nak. (Pl. II, fig. 2), *Stenozonotriletes reticulatus* Naum. (Pl. II, fig. 3), *Stenozonotriletes reticulatus* Naum (Pl. II, fig. 3), *Stenozonotriletes facilis* Isch. var. *prae-crassus* Isch. (Pl. II, fig. 4), *Stenozonotriletes laevigatus* Naum. (Pl. II, fig. 5), *Stenozonotriletes denticulatus* Naum. (Pl. II, fig. 6), *Stenozonotriletes lasius* Naum. (Pl. II, fig. 7), *Stenozonotriletes sinusporoides* Ağr. (Pl. II, fig. 8), *Triaxisporites pierarti* Nak. (Pl. II, fig. 9), *Simozonotriletes pusillus* Isch. (Pl. II, fig. 10), *Densosporites partitus* Nak. (Pl. II, fig. 20), *Okayisporites largus* Nak. (Pl. II, fig. 21), *Okayisporites granulipunctatus* (Lub.) Ağr. (Pl. II, fig. 22), *Mooreisporites cf. fustis* Nev. (Pl. II, fig. 25), *Ahrensisporites pustulosus* Ağr. (Pl. III, fig. 3), *Schulzospora elongata* H., S. & M. (Pl. III, fig. 7), *Shulzospora triangulata* Nak. (Pl. III, fig. 8), et de *Schulzospora membrana* Nak. (Pl. III, fig. 9).

b. Formes caracteristiques du Westphalien A du secteur d'Üzülmez

Les especes paraissant etre caracteristiques de la microflore d'age Westphalien A d'Üzülmez sont *İbrahimispores rarispinosus* Ağr. (Pl. III, fig. 18), *Leiotriletes exilis* Nak. (Pl. III, fig. 10), *Leiotriletes pseudoauriculus* Nak. (Pl. III, fig. 11), *Punctatisporites fissus* H., S. & M. (Pl. III, fig. 12), *Punctatisporites glaber* (Naum). Play. (Pl. III, fig. 13), *Barssisporites cam* Nak. (Pl. III, fig. 22), *Converrucosisporites turcicus* Ağr. (Pl. III, fig. 15), *Bellispores dokukensis* Ağr. (Pl. III, fig. 28), *Canisporites corpulantus* Nak. (Pl. IV, fig. 3), *Lycospora microcdrbonicus* Art. (Pl. IV, fig. 6), *Lycospora minutus* (Isch.) Ağr. (Pl. IV, fig. 5), *Lycospora venusta* Nak. (Pl. IV, fig. 7), *Densosporites radiatus* (Dyb. & Jach.) Ağr. (Pl. IV, fig. 15), *Densosporites karczewskii* (Dyb. & Jach.) Ağr. (Pl. IV, fig. 16), *Densosporites landesii* Stap. (Pl. IV, fig. 9), *Densosporites microana-*

tolicus Art. (Pl. IV, fig. 10), *Densosporites lobatus* Kos. (Pl. IV, fig. 11), *Densosporites duriti* Pot. & Kr. (Pl. IV, fig. 12), *Densosporites baykali* Aky. (Pl. IV, fig. 13), *Densosporites cingulibullatus* Nak. (Pl. IV, fig. 14), *Okayisporites beatns* Nak. (Pl. IV, fig. 23), et *Triquitrites arculatus* (Loose) Wils. & Coe. (Pl. IV, fig. 26).

D'autre part, nous avons pu determiner les especes indiquees ci-dessous qui semblent caracteriser le Westphalien A inferieur, moyen et superieur tels qu'ils sont limites par Egemen (19) d'apres ses etudes paleobotaniques:

— Westphalien A inferieur: *Sinuspores habilis* Nak. (Pl. IV, fig. 1), *Densosporites seducti* Nak. (Pl. IV, fig. 18), *Tendosporites subalatus* Hacq. et Barss (Pl. IV, fig. 20) et *Mooreisporites principals* Nak. (Pl. IV, fig. 28).

— Westphalien A moyen: *Stenozonotriletes zonadicus* Naum. (Pl. III, fig. 20), *Triaxisporites compositus* Nak. (Pl. III, fig. 25), *Simozonotriletes compactus* Nak. (Pl. III, fig. 26), *Cal-Usporites belliformis* Nak. (Pl. IV, fig. 4), *Lycospora micrograna* Hacq. & Barss. (Pl. IV, fig. 8), *Densosporites coronarius* (Dyb. & Jach.) Nak. (Pl. IV, fig. 17), *Cirratriradites trizonarius* Dyb. & Jach. (Pl. IV, fig. 21), *Triquitrites simplex* Bhard. (Pl. IV, fig. 25), et *Ahrensisporites fabulosus* Nak. (Pl. IV, fig. 30).

- Westphalien A superieur: *Granulatisporites hilarus* Nak. (Pl. III, fig. 14), *Convolutispora undulata* Nak. (Pl. III, fig. 16), *Apiculatisporites jucundus* Nak. (Pl. III, fig. 17), *Stenozonotriletes trivalvis* Naum. (Pl. III, fig. 19), *Stenozonotriletes crassicingulatus* Nak. (Pl. III, fig. 21), *Barssisporites minus* Nak. (Pl. III, fig. 23), *Barssisporites mollis* Nak. (Pl. III, fig. 24), *Bellispores mediocris* Nak. (Pl. III, fig. 27), *Canisporites singularis* Nak. (Pl. IV, fig. 2), *Tendosporites divinus* Nak. (Pl. IV, fig. 19), *Okayisporites mirabilis* (Lub.) Ağr. (Pl. IV, fig. 22), *Triquitrites tricuspis* (Horst) Pot. & Kr. (Pl. IV, fig. 24), *Mooreisporites sinuformis* Nak. (Pl. IV, fig. 27) et *Ahrensisporites stigmosus* Nak. (Pl. IV, fig. 29).

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P L A N C H E S

(I a IV)

Toutes les photos sont au grossissement X 500

PLANCHE - I

(Namurien)

Fig. 1 - *Punctatisporites minutus* Kos.

Fig. 2 - *Punctatisporites intdus* Art.

Fig. 3 - *Punctatifporites munilus* Kos.

Fig. 4 - *Punctatisporites amasrensis* Ağr.

Fig. 5 - *Punctatisporites asptratus* (Luh.) Aky.

Fig. 6 - *Punctatispnrites üzülmezensis* Nak.

Fig. 7 - *Punctatisporites bacatus* Nak.

Fig. 8 - *Pachytriletes pcrfectus* Nak.

Fig. 9 - *Culammpora coronata* Ağr.

Fig. 10 - *Granulalisporites rudigratiulatus* Stap.

Fig. 11 - *Granulatisporites trilobotorosus* Nak.

Fig. 12 - *Verrucosisporites rufus* Butt. & Will.

Fig. 13 - V*errucosisporites kari* Nak.

Fig. 14 - V*errucosispurites irregularis* Nak.

Fig. 15 - *Cunvolutispora mira* Nak.

Fig. 16 - *Lophotriletes perjectus* Nak.

Fig. 17 - *Lophotriletes moderatus* Nak.

Fig. 18 - *Acanthotriletes castaneus* Butt. & Will.

Fig. 19 - A*canthotriletes dliatus* (Knox) Pot. & Kr.

Fig. 20 - *Horriditriletes grandis* Nak.

Fig. 21 - *Horriditriletes rudis* Nak.

Fig. 22 - *Camptotriletes Jansoniusi* Nak.

Fig. 23,24 - *Egemenispontes vermiformis* (Hugh. & Play.) Ağr.

Fig. 25 - *Reticulatisporites punctatus* Nak.

Fig. 26 - *Reticulatisporites waltzi* Ağr.

Fig. 27 - *Reticulatisporites largus* Nak.

Fig. 28 - *Dictyotriletes minor* Naum.

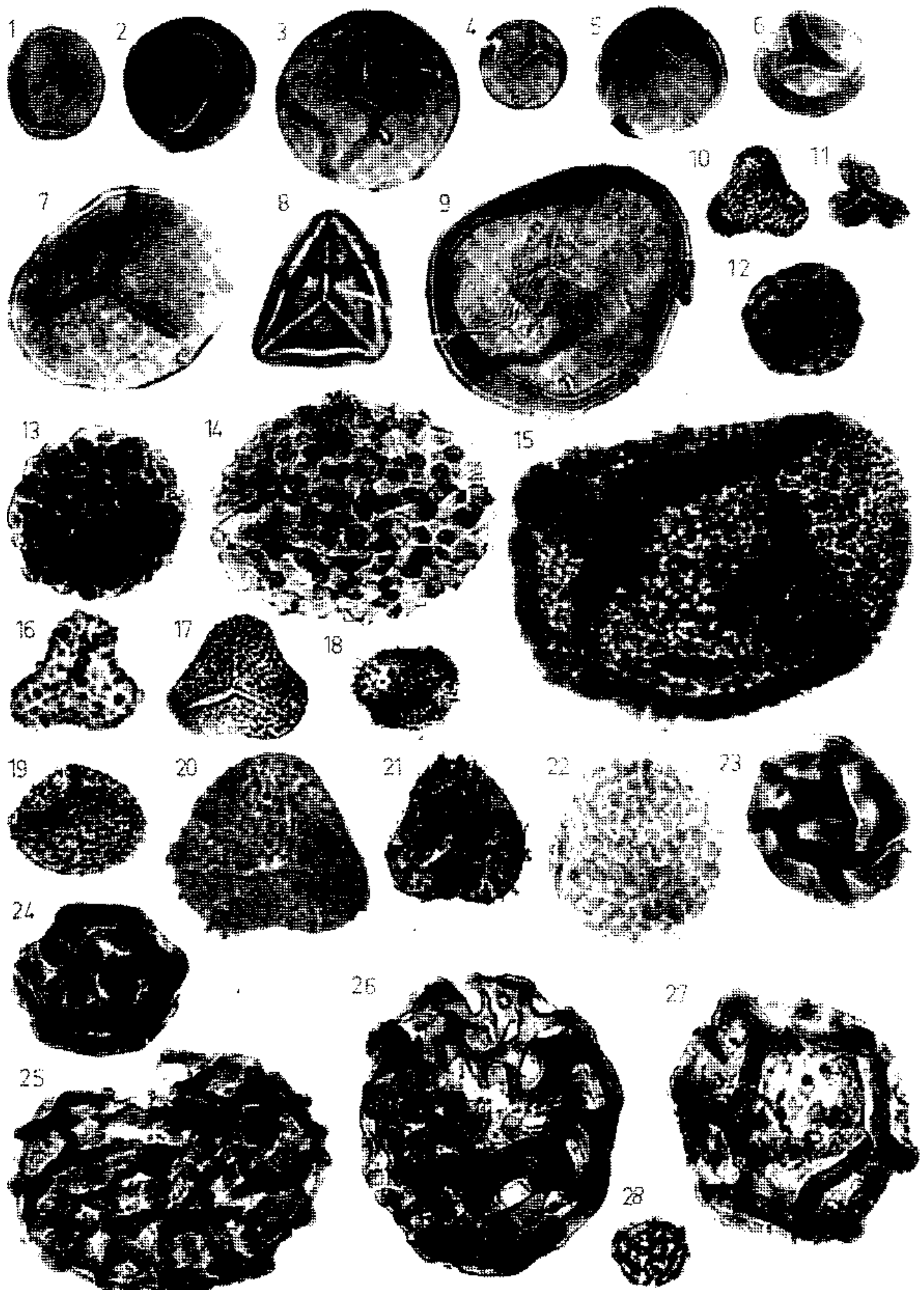
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PLANCHE - II

(Namurien)

Fig. 1 - *Reticulatisporites baykali* Nak.

Fig. 2 - *Knoxisporites altInlIi* Nak.

Fig. 3 - *Stenozonotriletes reticulatus* Naum.

Fig. 4 - *Stenazonotriletes facilis* Isch. var. *prae-crassus* Isch.

Fig. 5 - *Stenozonotriletes laerigatus* Naum.

Fig. 6 - *Stenozonotriletes denticulalus* Isch.

Fig. 7 - *Stennzunotriletes lasius* Naum.

Fig. 8 - *Stenozonutriletes sinusporoides* Ağr.

Fig. 9 - *Triaxisporites pierarti* Nak.

Fig. 10 - *Simozonotriletes pusillus* Isch.

Fig. 11 - *Rotaspora knoxi* Butt. & Will.

Fig. 12,13 - *Rotaspnra obtusus* (Naum.) Ağr.

Fig. 14 - *Rotaspora annellitus* (Horst; Pet. & Kr.

Fig. 15 - *Rotaspora horsti* Nak.

Fig. 16 - *Prucoronaspora ambigua* Butt. & Will.

Fig. 17 - *Procronaspora rarigranulata* Ağr.

Fig. 18 - *Procoronaspora tenuigranulata* Nak.

Fig. 19 - V*eresisporites tribullatus* Nak.

Fig. 20 - *Densosporites partitus* Nak.

Fig. 21 - *Okayisporites largus* Nak.

Fig. 22 - *Okayisporites granulipunctatus* (Lub.) Ağr.

Fig. 23 - *Yahşımanisporites batillatus* (Hugh. & Play.)Ağr.

Fig. 24 - *Yahşımanisporites subbransonii* Ağr.

Fig. 25 - M*ooreisporites* cf. f*ustis* Nev.

Fig. 26 - *Tripartites primitivus* Ağr.

Fig. 27 - *Tripartites retuslus* Sch.

Fig. 28 - *Tripartites annosus* (Isch.) Sull. & Nev.

Fig. 29 - *Tripartites simplicissimus* Dyb. & Jach.

Fig. 30 - *Triportites ianthinus* Butt. & Will.

Fig. 31 - *Tripartites granulatus* Ağr.

Fig. 32 - *Tripartitus auritus* (Isch.) Ağr.

Fig. 33 - *Tripartites vermiculatus* Ağr.

Fig. 34 - *Tripartites cassiformis* (Isch.) Nak.

Fig. 35 - *Tripartites parrus* (Isch.) Ağr.

Fig. 36 - *Tripartites crhtatus* Dyb. & Jach.

Fig. 37 - *Tripartites trifaliatus* Dyb. & Jach.

Fig. 38 - *Tripartites variabilis* (Isch.) Ağr.

Fig. 39 - *Tripartites aductus* (Isch.) Sull & Nev.

Fig. 40 - *Tripartites reqularis* Nak.

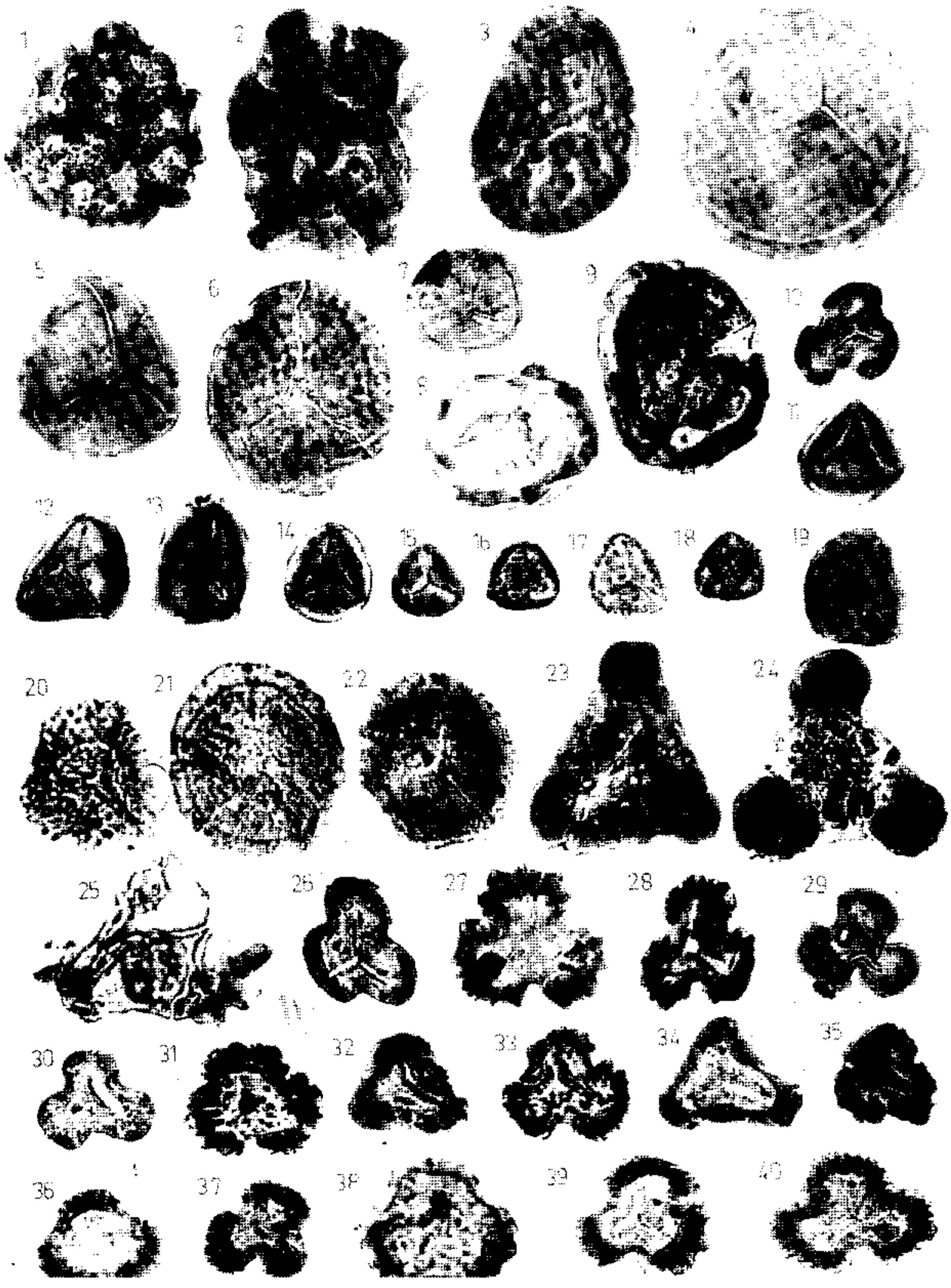
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PLANCHE - III

(Namurien - Westphalien A)

Namurien

Fig. 1 - *Tripartites turbidus* Nak.

Fig. 2 - *Tripartites obtusus* Nak.

Fig. 3 - *Ahrensisporitrs puslulatus* Ağr.

Fig. 4,5 - *Pekmezcileripollenites mediatiamurensi* Ağr.

Fig. 6 - *Perisaccus oblongus* Ağr.

Fig. 7 - *Schulzutpora elongata* H., S. & M.

Fig. 8 - *Schuhospora triangulata* Nak.

Fig. 9 - *Schulzospora membrana* Nak.

Westphalien A

Fig. 10 - Le*iotriletes exilis* Nak.

Fig. 11 - *Leiotriletes pseudoauriculis* Nak.

Fig. 12 - *Punctatisporites fissus* H., S. & M.

Fig. 13 - *Punctatitporites glaber* (Naum.) Play.

Fig. 14 - *Granulatisporites hilarus* Nak.

Fig. 15 - *Conrcrrucosisporites turcicus* Ağr.

Fig. 16 - *Convolutispora undulata* Nak.

Fig. 17 - *Apiculatisporites jucundus* Nak.

Fig. 18 - *ibrahimispores ranspinusus* Ağr.

Fig. 10 - *Stenozonotriletes trivalvis* Naum.

Fig. 20 - *Stenozonotriletes zonadicus* Naum.

Fig. 21 - *Stenozonotriletes crassicingulatus* Nak.

Fig. 22 - *Barssisporites cani* Nak.

Fig 2.1 - *Barssisporites minus* Nak.

Fig. 24 - *Barssisporites mollis* Nak.

Fig. 25 - *Triaxisporites compusitus* Nak.

Fig. 26 - *Simozonotriletes compactus* Nak.

Fig. 27 - *Bellispores mediocris* Nak.

Fig. 28 - Be*llispores dökükensis* Nak.

Fig. 29 - *Sinuspores habilis* Nak.

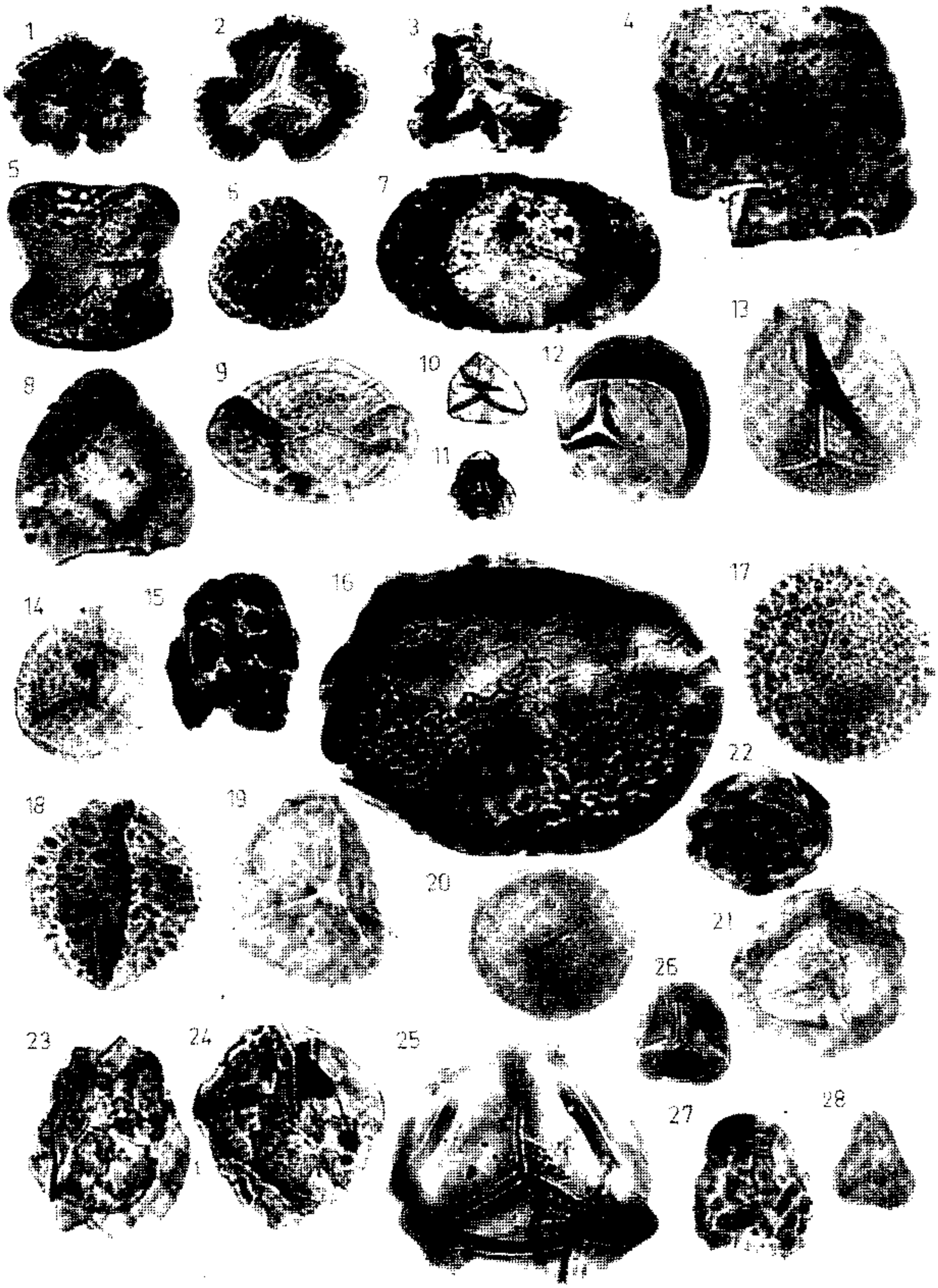
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PLANCHE - IV

(Westphalien A)

Fig. 1 - *Sinuspores habilis* Nak.

Fig. 2 - *Canisporites Singularis* Nak.

Fig. 3 - *Canisporites corpulentus* Nak.

Fig. 4 - *Callisporites belliformis* Nak.

Fig. 5 - *Lycospora minutus* (Isch.) Ağr.

Fig. 6 - *Lycospora microcarbonicus* Art.

Fig. 7 - *Lycospora reuusta* Nak.

Fig. S - *Lycospora micrograna* Hacq. & Barss.

Fig. 9 - *Densospotites landesii* Stap.

Fig. 10 - *Densosporites microanatolicus* Art.

Fig. 11 - *Densosporites lobatus* Kos.

Fig. 12 - *Densosporites duriti* Pot. & Kr.

Fig. 13 - *Densosporites baykali* Aky.

Fig. 14 - *Densosporites cingulibullatus* Nak.

Fig. 15 - *Densosporites radiatus* (Dyb. & Jach.) Ağr.

Fig. 16 - *Densosporites karczewskii* (Dyh. & Jach.) Ağr.

Fig. 17 - *Densosporites coronarlus* (Dyh. & Jach.) Nak.

Fig. 18 - *Densosporites seducti* Nak.

Fig. 19 - *Tendosporites divinus* Nak.

Fig. 20 - *Tendosporites subalatus* Hacq & Barss.

Fig. 21 - *Cirratriradites trizonarius* Dyh. & Jach.

Fig. 22 - *Okayisporites mirabilis* (Lub.) Ağr.

Fig. 23 - *Okayisporites beatus* Nak.

Fig. 24 - *Triquitrites tricuspis* (Horst) Pot. & Kr.

Fig. 25 - *Triquitrites simplex* Bhard.

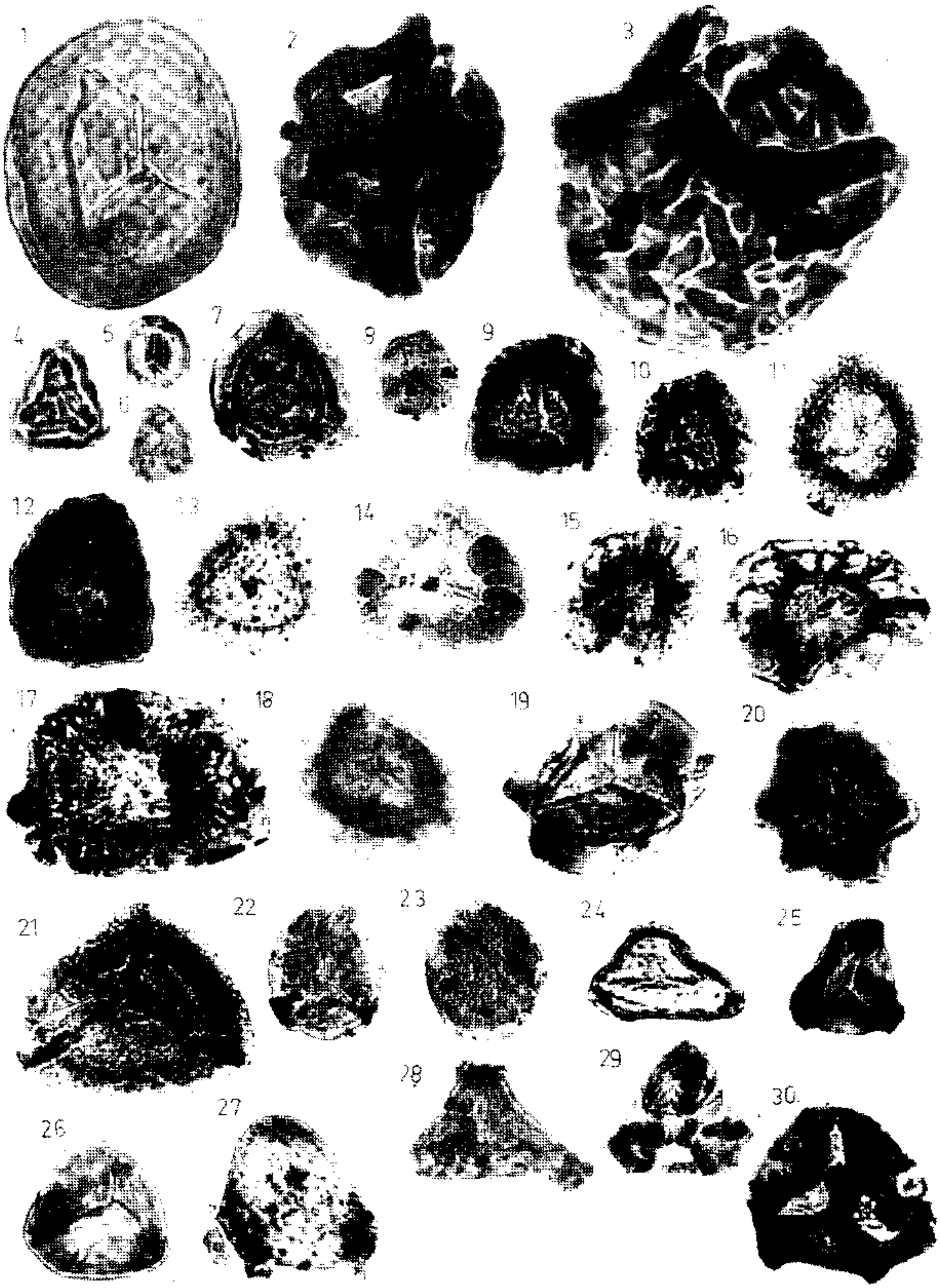
Fig. 26 - *Triquitrites arculatus* (Loose) Wils. & Coe.

Fig. 27 - *Mooreisporites sinuformis* Nak.

Fig. 28 - *Mooreisporites pirincipalis* Nak.

Fig. 29 - *Ahrensisporites stirmosus* Nak.

Fig. 30 - *Ahrensisporites fabulosus* Nak.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NEW EARLY MESOZOIC BRACHIOPODS FROM SOUTHERN TURKEY

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ABSTRACT. — New Late Triassic and Early Jurassic brachiopod faunas are described from the Taurus Mountains in Southern Turkey. They include the distinctive Norian rhynchonellid *Halorella amphitoma* (not previously recorded from Turkey), the aberrant Upper Norian rhynchonellid Carapezzia (only previously recorded from Austria and Sicily) and Sinemurian or Pliensbachian faunas. The significance of these typically North European faunas in a Tethyan realm is discussed.

I. INTRODUCTION

The brachiopods described in this paper were found in the course of field mapping in the Taurus chain of southern Turkey (Brunn & al., 1971) and were discussed with and identified by one of us (D.V.A.). They are worthy of special consideration, firstly because of the evidence of age they provide to several formations in an area of structural complexity, and secondly because of their ecological and biogeographical interest.

II. STRATIGRAPHY

The Western Taurides lie along the Mediterranean coasts of southern Turkey in direct prolongation of the Hellenides, between the Agean sea and the meridian of Cyprus. Stratigraphic and tectonic studies in part of this chain (Brunn & al., 1971) have disclosed several large nappes overlying relatively autochthonous carbonate series which appear in a lower position: these series constitute the Bey Dağları massif west of Antalya, and the Pisidian autochthonous carbonate series which appear in a lower position east and north of Isparta. The stratigraphy of these very thick series (up to 3000 m) composed mainly of shallow-water carbonates or siliceous detritic formations, ranges from Cambrian to Eocene. The attribution, of Triassic and Liassic ages to some important formations of the relatively autochthonous series in the Western Taurides was based upon several faunas, including several Brachiopod assemblages.

Up to now, no Mesozoic Brachiopods have-been described from the Taurus chain, and these assemblages clearly exhibit unexpected affinities with European types. Prior to their paleontological description, a short stratigraphical introduction will summarize their geological setting.

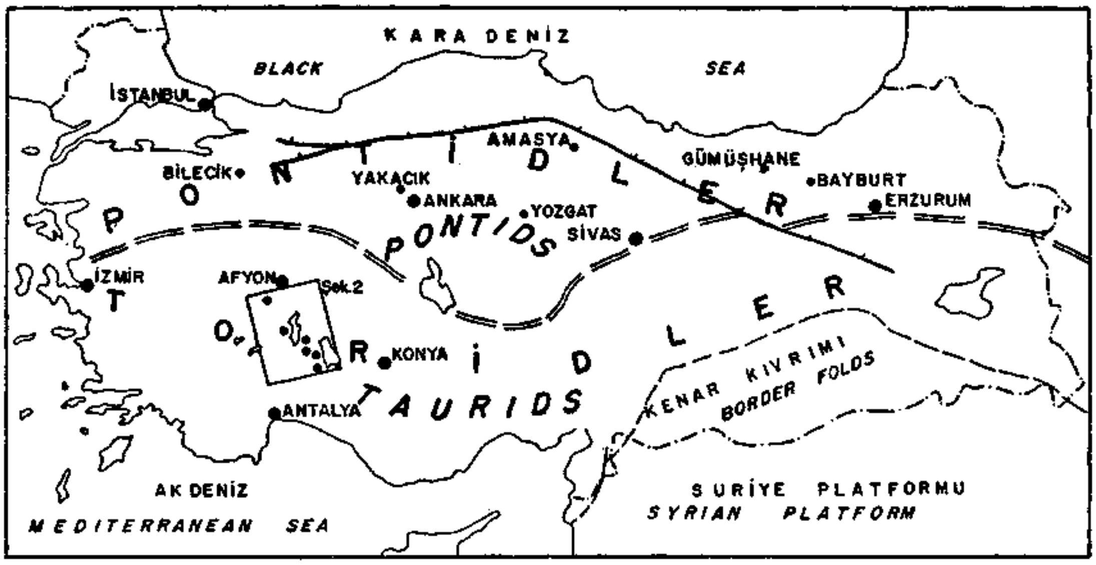

Fig. 1 - Sketch map of Turkey showing the emplacement of the different faunas discussed in the text. The double interrupted line shows the approximate position of the main ophiolitic «scar» separating the Pontids from the Taurids.

Several stratigraphical type-series have been defined in the autochthonous Pisidian Taurus (Brunn *et al.,* 1971) among which the Anamas Dağ series, the Barla Dağ series and the Sandıklı series (Gutnic, 1977) contain occasional Brachiopod faunas in various Triasico-Liasic formations.

A. The Anamas Dağ series (Brunn & al., 1971; Dumont, 1976; Gutnic, 1977)

Largely represented east of the lake of Eğridir, the Anamas Dağ series comprises a thick succession of Upper Triassic shales and sandstones at the base (Kasımlar shales), followed by shallow water carbonates (Menteşe Dolomite, Leylek Limestone) of Upper Norian (Rhaetian)age, often overlain by coarse detritals (Çayır Fm.) and succeeded by algal limestones (Yassıviran lst)of Liassic age.

The Kasımlar shales consist of alternating argilaceous black shales and predominantly fine-grained sandstones containing numerous patch-reefs and biostromal limestone beds which protrude conspicuously from the shales. These limestone lenses are highly fossiliferous, with a great variety of organisms including Corals, Bryozoa, calcareous sponges and algae, Crinoids, Lamellibranchs, while in the black shales, different faunas include *Halobia* sp., *Daonella* sp., Ammonites *(Arcestes* sp., *Pinacoceras* sp.,? *Juvavites sp.)* along with *Aulacoceras timorensis* Warriner and *Heterastridium congkbatum* Reuss which indicate Upper Carnian to Upper Norian ages for this formation, according to places. In spite of its great thickness (1000 m ?) the Kasımlar shales appear as a shallow water deposit upon a subsiding carbonate platform.

Fossiliferous localities 1 and 2 belong to the Kasımlar shales:

Locality N° 1 (İslibucak) is a loose limestone block found in the Kasımlar shales about 1 km west of the locality İslibucak on the track climbing to the high pass of İncebel, south of the Dipoyraz Dağ. In this block, many Lamellibranchs *(Paleonucula* sp.), a few Ammonites of Upper Norian type, and Rhynchonellids are in a surprisingly close association. The Brachiopods include only one species *Halorella amphitoma,* determined by H. Termier (pers. comm. to O.M.), and considered as dwarf forms by D.V.A.

Locality N° 2 (Terziler) is situated along the road from the village of Anamas to Yaka, at the cross-road leading to the village of Terziler, north of the road, near a small fountain. Several large blocks of dark limestones are conspicuously protruding from the black Kasımlar shales, and are unusually fossiliferous (Collignon & al., 1970): Pelecypods *(Pleuromya* sp., *Mytilus* sp. *Modiola* sp., gastropods *Murchisonia* sp.) cephalopods of Upper Triassic age are closely associated with numerous Rhynchonellids (Halorella).

Localities n° 3 & 4 (Banos) are situated about 4 km east of the village of Gökçehüyük (new name for Banos) and include two fossiliferous outcrops: one is situated precisely in the pass between the valley of Banos to Bacik, and the long depressed area of Sorkun Yayla, at the foot of high Anamas Dag. There, in a faulted position between Triassic shales (with numerous Heterastridium) and the overlying Menteşe Dolomite, is found a large limestone block containing numerous Terebratulidlooking Brachiopods (Carapezzia). A few hundred meters northwards, along the path leading towards the Anamas Dag, about ten meters of tectonised limestones have also yielded some Lamellibranchs, Gastropods and Brachiopods *(Fissirhynchia fissicostata, Austrorhynchia* sp.).

Above the Kasımlar shales, the *Menteşe Dolomite* consists of white, massive, fine-grained dolomite with frequent supra-tidal textures (bird eyes, laminar vugs) about 150 m thick. At its top, the *Leylek limestone* shows well stratified beds with alternating stromatolites and Megalodonts (cf. Lofer cyclothems) with abundant microfauna (Involutinidae, Triasina) of Upper Norian age (Vegh-Neubrandt *et al,* 1976).

The Menteşe and Leylek shallow-water carbonates are overlain by an irregular deposit of sandstones and conglomerates (Çayır formation, 0 to 200 m) which, in turn, are succeeded by thick black limestones, the *Yassıviran Limestones,* of Liassic age.

B. The Bark Dag series (Gutnic, 1968, 1977; Brunn & al., 1971)

The Barla Dağ massif (2800 m) is situated on the W side of the Eğridir Lake, and its stratigraphical series closely ressembles that of the Anamas Dag series. The Upper Triassic dolomites, or Barla Dag Dolomite, is extremely thick (over 700 m) and is directly overlain by the Yassıviran limestones (300 m), which have yielded a small Brachiopod fauna on the eastern flank of the Barla Dag (Gutnic, 1977).

The fossiliferous locality (N° 5) lies about 2 km east of the Karabeygir Tepe, at an altitude of 1650 m on the path between the villages of Barla and Garipköy. The Yassiviran limestones consist of well bedded black micrites and packstones with abundant oncoides, shell fragments, benthonic Foraminifera and Dasycladaceae. The most significant fossils include two well known Tethian genera: *Paleodasycladus mediterraneus* Pia and *Orbitopsella praecursor* which are reliable markers for Lower-Middle Lias throughout the Mediterranean area.

In contrast with the high energy environment of the scattered reefs in the Kasımlar shales, the Yassıviran limestones exhibit moderate to low energy levels, although of relatively shallow-water origin.

C. The Sandıklı series (Brunn & *al,* 1971; Gutnic, 1977)

About 70 km north of Isparta, in the region of Sandıklı, the relatively autochtonous series of the Pisidian Taurus includes Mesozoic formations transgressive upon an epimetamorphic basement. Coarse conglomerates and red sandstones (Verrucano facies) of possible Upper Trias to Lower Liassic age are followed by a thick terrigenous formation, the Derealam shales (Gutnic, *in* Brunn &

al., 1971). This formation consists mainly of silty shales and sandstones with extremely abundant benthonic faunas (Pelecypods, Gastropods, Corals and Brachiopods) in its lower half. Above, the facies grade into finer shales and limestone beds with Ammonites, among which *Polyplectus discoides* indicates an Upper Lias age. The series ends with thick Jurassic and Cretaceous neritic limestones. The Brachiopod fauna described here (N° 6) belong to the lower part of the Derealanı shales which are well exposed near the main road from Afyon to Isparta, on a small hill (Karatepe) 7 km south of Sandıklı. There, the Derealam shales contain massive accumulations of Lamellibranchs (Limidae Astartidae), Corals (Stylophyllidae), and Brachiopods.

In spite of the proximity of the Sandıklı series and Barla Dağ series, no correlations are possible, due to major lithological differences.

D. The Antalya Nappes (Eğridir region)

About 20 km E-SE from Eğridir, the long depressed area of Sorkun Yayla exhibits large outcrops of alternating sandstones and marls, radiolarites and pillow-lavas which belong to the Lower Antalya units in this area (equivalent to the Alakır Çay unit in Antalya region). The fossiliferous locality N° 7 is situated about half way on the western flank of Sorkun Yayla, 4 km North of the village of Bucak. Several inliers in the Antalya units show repeated exposures of sandstones, sandy limestones and shales containing very large blocks of dark limestones (more than 10 cubic meters) with poorly preserved Ammonites, Gastropods and Brachiopods. Due to the tectonic position of the sandstones containing the fossiliferous blocks, their precise stratigraphical setting in the Antalya nappes is still uncertain.

III. SYSTEMATIC PALEONTOLOGY

Genus : Halorella BITTNER, 1884

1884 — *Halorella* Bittner, p. 107.

1890 — *Halorella* Bittner, p. 172.

1960 — *Halorella* Bittner, Ager, p. 158.

1963 — *Halorella* Bittner, Dagis, p. 53.

1968 — *Halorella* Bittner, Ager, p. 54.

Type species: *Terebratula amphitoma* BRONN, 1832

After the detailed description given of this genus by Bittner in his classic work on the Alpine Triassic brachiopods, practically nothing was done until the last decade. Ager (1960) then split the genus into Halorella s.s. and a new genus Halorelloidea. This division was accepted by Dagis (1963) who published the first details of the internal structures. The type species. *H. amphitoma,* is widely distributed around the world (Ager, 1968) and the material from southern Turkey certainly belongs to that species.

Halorella amphitoma (BRONN)

1832 — *Terebratula amphitoma* Bronn.

1890 — *Halorella amphitoma* (Bronn), Bittner, p. 183.

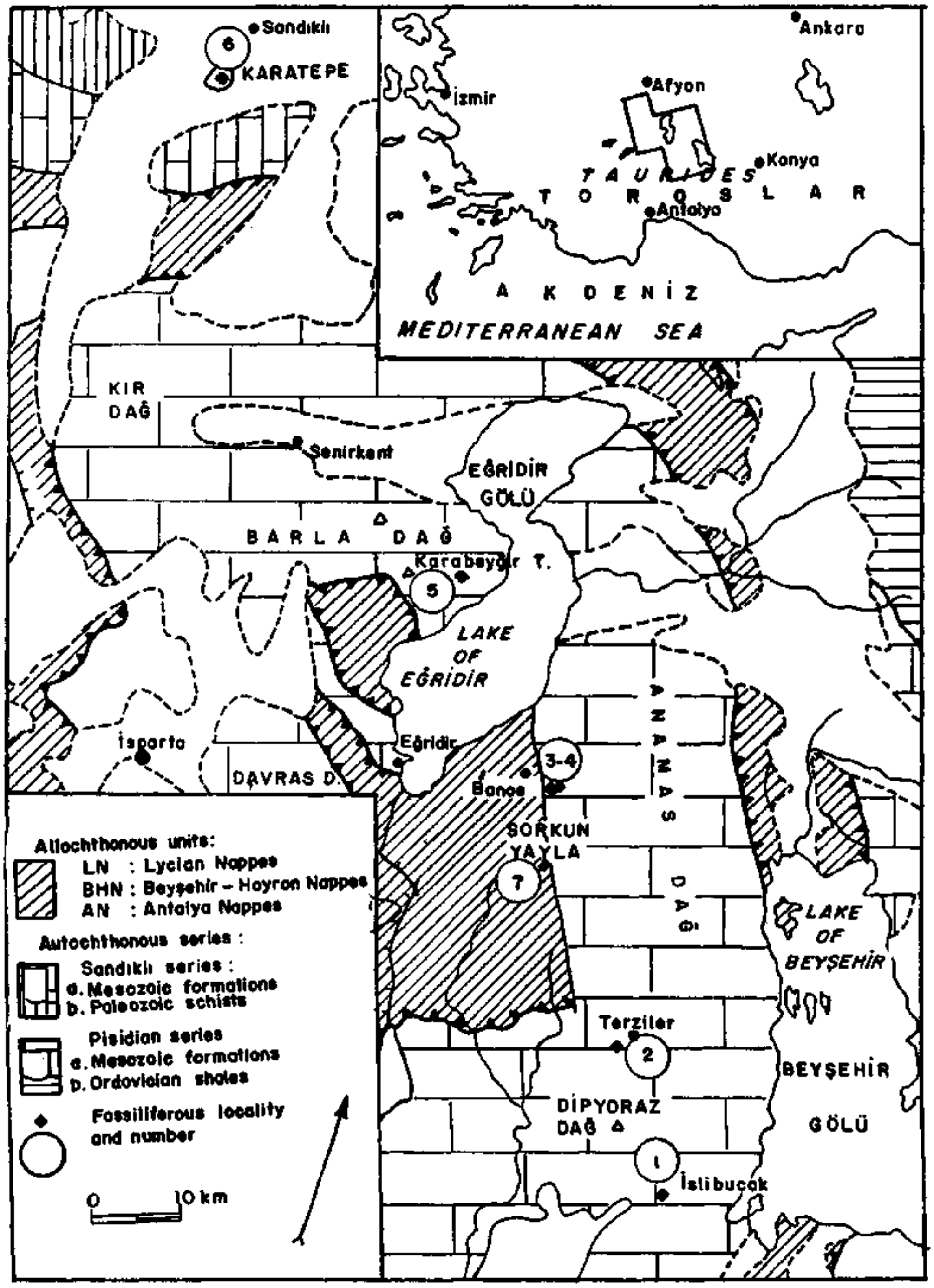

Fig. 2 - Geological sketch map of the Isparta region (W Taurus) and the various localities cited in the text.

1963 — *Halorella amphitoma* (Bronn), Dagis, p. 54.

1968 — *Halorella amphitoma* (Bronn), Ager, p.54.

About 20 specimens of this species were found in a limestone block within the flysch near Terziler (Fig. 2). This is undoubtedly the form whose external characters were well described by Bittner (1890) and has been recorded in many places outside the type area of the Austrian Alps (Ager, 1968).

Externally the Turkish specimens show the same range of variation as that described by Bittner (1890), with the characteristic opposed sulci and sharp costae ranging from 10 to 14 on each valve. The variants with fewer costae would fall within Bittner's variety *rarecostata.*

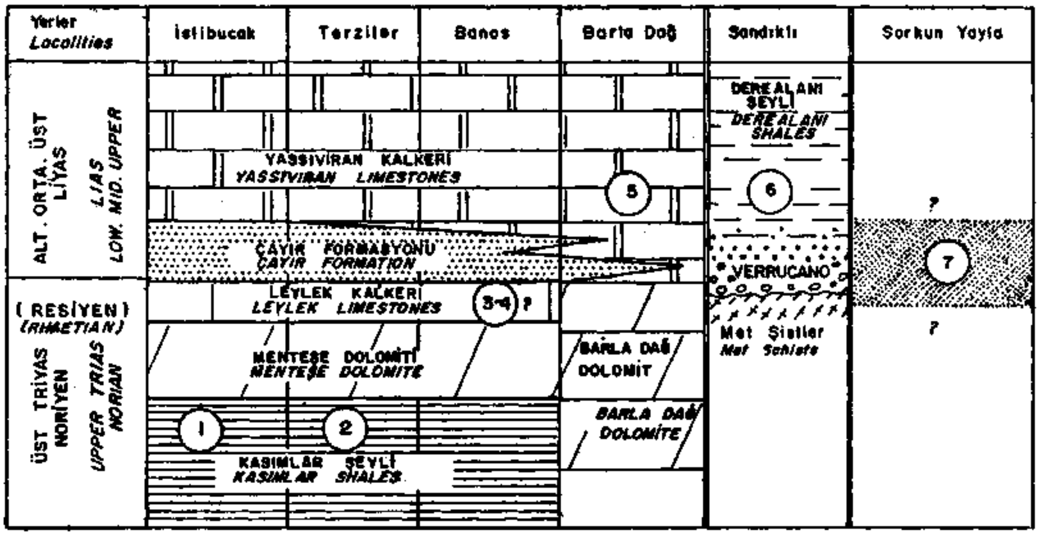

Fig. 3 - Schematic stratigraphical series in the Western Taurides and relative emplacement of the Brachiopod faunas.

No. 1 : *Halorella amphitoma* Bronn
No. 2 : *Halorella amphitoma* Bronn
No. *3-4*: *Carapezzia globosa* (Carapezza & Schopen)
Carapezzia geyeri Bittner
Fissi rhynchia fissicostata Suess
Austrirhynchia cornigera (Schafhaütl)
Rhaetina sp.

Note: Emplacement of samples 3 & 4 is doubtful.

No. 5 : *Cuneirhynchia oxynoti* (Quenstedt)
Piarorhynchia sp. ?
Tetrarhynchia sp. ?
Lobothyris sp. ?
No. 6 : *Calcirhynchia calcaria* Buckman
No. 7 : *Aulacothyris* cf. *A. resupinata* (Sowerby)
Cincta numismalis (Lamarck)
Lobothyris sp.
Spiriferina sp.

Internal characters, unfortunately, were not so well preserved as the external and though a number of specimens were serially sectioned, none produced a perfect set of sections but fig. 4 shows the best set available. These are sufficient to confirm the identification and show a strong resemblance to the sections published by Dagis (1963) of specimens from the Pamirs, in the southern U.S.S.R. and by Ager (1968) of specimens from the type area in Austria and from Oregon. It may be significant that no dorsal median septum was observed in the Turkish specimens. This matches the situation in the Soviet forms and differs from that in the topotypes and in the American forms.

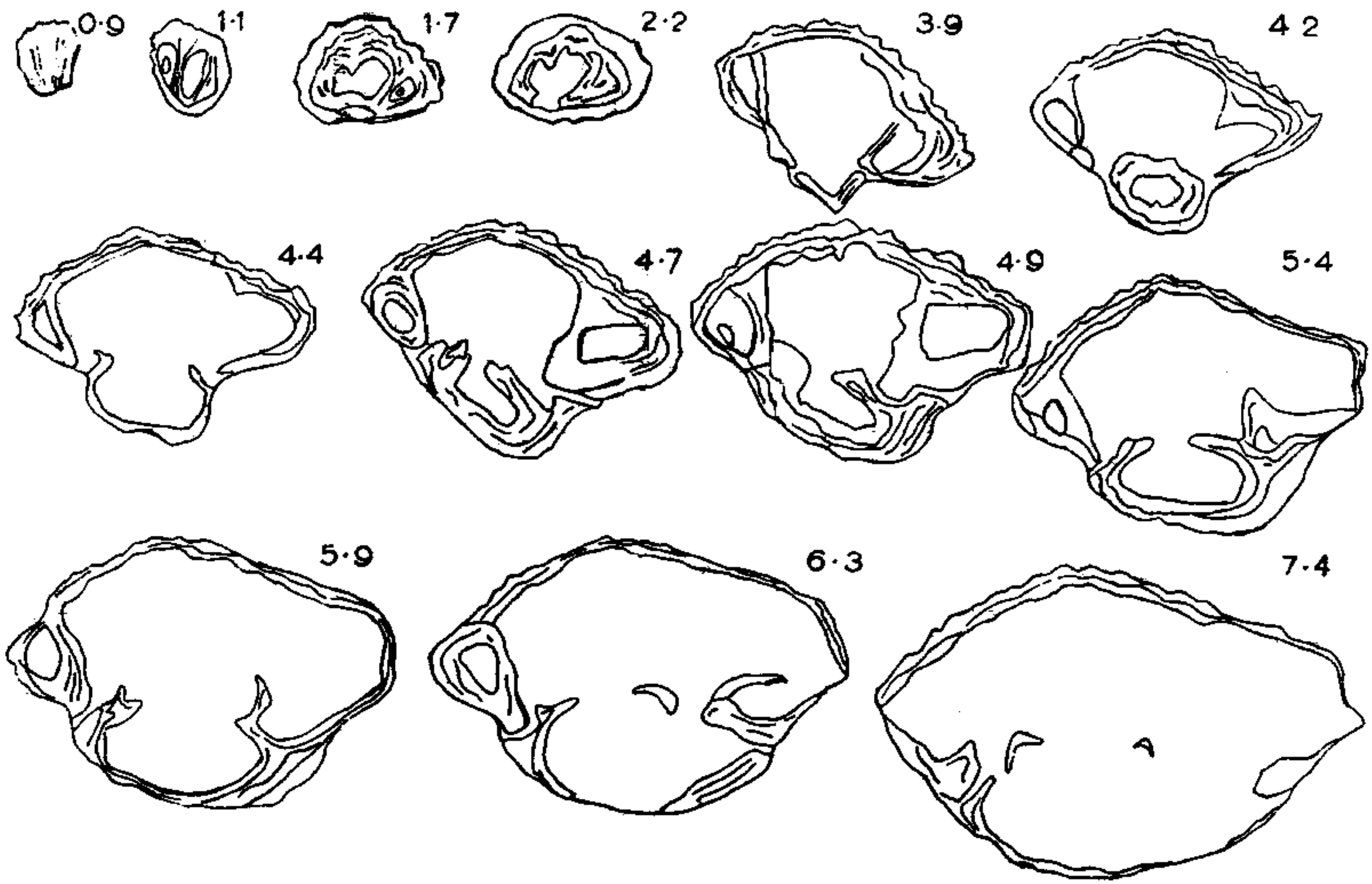

Fig. 4 - **Serial transverse sections of *Halorella amphitoma* (Bronn)from the shales near Terziler. The small figures indicate the distance (in millimetres) from the posterior end. The pedicle value in each case is uppermost.**

Genus : Carapezzia TOMLIN, 1930

1899 — *Rhynchonellina (Geyeria)* Carapezza & Schopen, p. 248.

1930 — *Carapezzia* Tomlin, p. 24.

1965 — *Carapezzia* Tomlin; Ager, p. 603.

Type species: *Rhynchonellina (Geyeria) ghbosa* CARAPEZZA & SCHOPEN, 1899

This genus was first proposed by Carapezza and Schopen on the basis of material from the Rhaetian of the Gailtaler Alps in Southern Austria, and the Lower Jurassic of Sicily. The name Geyeria was an invalid junior homonym and the name Carapezzia was substituted by Tomlin. It is a very unusual rhynchonellid with internal characters reminiscent of Peregrinella from the Lower Cretaceous and Eoperegrinella from the Upper Devonian (Ager 1968, p. 69). It differs from both these forms, however, in its completely smooth shell . It probably has affinities with Rhynchonellina, with which it was originally grouped. Again the internal structures were not very well preserved in the Turkish specimens, but were sufficiently clear to show the characteristic form of the crura arising directly from the median septum.

Carapezzia globosa (CARAPEZZA & SCHOPEN)

1899 — *Rhynchonellina (Geyeria) globosa* Carapezza & Schopen, p. 248.

1965 — *Carapezzia globosa* (Carapezza & Schopen), Ager, p. 603.

This species was first described by Carapezza and Schopen from the supposed Lower Jurassic of Sicily, though the original authors emphasised its close resemblance to the Rhaetian species *geyeri* (in fact they chose their subgeneric name with this in mind). The distinguishing features of this species, that is its extremely globose form and massive, strongly incurved beak are only seen in one or two large specimens up to more than 40 mm long. These come from a single mass of dark shelly limestone lower down in the Col de Banos. They are accompanied by smaller specimens with upright beaks and unconcealed delthyria which may confidently be placed in C. *geyeri*. It is therefore not thought that there is any clear dividing line between this and the next species, as was apparent from the original figures of Bittner (1898) and Carapezza and Schopen (1899). In fact Bittner's first figures *ofgeyeri* (which were accompanied by what were probably the first set of serial sections ever published) are in many ways intermediate between the typical *globosa* and the typical *geyeri* as now understood. It seems probable that *globosa* merely represents *geyeri* reaching its maximum growth form under optimum conditions. It is doubtful if the differences are stratigraphically significant and there is no reason to believe that all these forms do not indicate a Rhaetian age.

Carapezzia geyeri (BITTNER)

1898 — *Rhynchonellina geyeri* Bittner; p. 387, Pl. 11, fig. 1-9; Pl. 12, fig. 1-7.

1899 — *Rhynchonellina (Geyeria) geyeri* Bittner; Carapezza & Schopen, p. 249.

1963 — *Rhynchonellina geyeri* (Bittner), Schlager, p. 69.

This species was described from a Rhaetian limestone above Oberpirkach, near Drautal, in the Gailtaler Alps of Southern Austria. Schlager (1963) suggested a Lower Jurassic age for one of the two known localities, but Pearson (personal communication, 1970) thinks that this is very unlikely on lithological grounds.

As already indicated, it is by no means certain that the separation of this form from the one just described is fully justified. The latter is merely a larger form with a greater incurvature of the beak. It may be significant, however, that the two species occur most abundantly at two different localities in Turkey.

The Turkish specimens of C. *geyeri* come from lumachelles in bedded argillaceous limestone on the Col de Banos on the west side of Anamas Dağ, South of Lake Eğridir. They are up to 26 mm long, equally biconvex, rectimarginate and smooth apart from the characteristic fine radial striae seen in the better preserved specimens. The beak is prominent, upright to slightly incurved, with a clearly displayed delthyrium and a large hypothyrid pedicle opening.

This is by far the most abundant brachiopod at this locality, though most specimens are poorly preserved. They are too numerous in the lumachelles to be counted individually.

Fissirhynchia fissicostata (SUESS)

1854 — *Rhynchonella fissicostata* Suess, p. 30.

1890 -- *Rhynchonella fissicostata* Suess, Bittner, p. 280.

1963 — *Septaliphoria fissicostata* (Suess), Dagis, p. 50.

1977 — *Fissirhynchia Fissicostata* (Suess), Pearson, p. 48.

A few fragmentary ribbed rhynchonellids which occur in the same lumachelles as C. *geyeri* may well belong to this well - known species. The species has been revised by Pearson and he placed it in his new genus Fissirhynchia. Dagis's reference of the species to the late Jurassic genus Septaliphoria is not acceptable. The species was first described from the Kossener Schichten in Austria and is one of the commonest forms in the European Rhaetian.

Rhaetina sp.

A few obscure terebratulids in the saine beds as the two previous species may belong to this genus, which is based on the well-known Rhaetian species *«Terebratula» gregaria* Suess (1854).

Austrirhynchia cornigera (SCHAFHAUTL)

1851 — Terebratula cornigera Schafhautl, p. 408.

1854 - *Rhynekonella cornigera* (Schafhautl), Suess, p. 31.

1959 — *Austrirhynchia cornigera* (Schafhautl), Ager, p. 325.

A single specimen from the same beds, somewhat expanded anteriorly andwith lateral branching costae, may belong to this highly distinctive rhynchonellid, which is entirely restricted to the Rhaetian rocks.

Aulacothyris cf. *A. resupinata* (J. SOWERBY)

1816 — *Terebratula, resupinata* J. Sowerby, p. 116.

1852 — *Terebratula resupinata* J. Sowerby, Davidson, p. 31.

1878 — *Waldheima resupinata* (J. Sowerby), Davidson, p. 177.

1879 — *Aulacothyris resupinata* (J. Sowerby), Douville, p. 277.

About 6 specimens of this form were found in boulders, within a flyscfrlike series at Sorkun Yaylası. They were accompanied by some poorly preserved gastropods and ammonites, and the other brachiopods mentioned below. The Aulacpthyrid is exactly like those described and figured by one of us (Ager, 1959) from the Lias of Yakacık, about 16 km north-northwest of Ankara. This similarity relates not only to their shape, but also to their small size and mode of preservation in a fine-grained ferruginous limestone.

There seems little doubt that this fauna is of the same age as that of Yakacık, i.e. Sinemumn or possibly Pliensbachian. This form differs from the Late Pliensbachian *A. resupinata* s.s. (the type species of the genus) in being narrower with a more rounded sulcus. It somewhat approaches *A. fusiformis* Rollier, of the same age, but is most probably an undescribed species coming from the previous stage.

Lobothyris sp.

Several specimens at Sorkun Yaylası seem to belong to this rather featureless Liassic terebratulid. Lobothyris is not, however, very helpful stratigraphically as it ranges all through the Lower Jurassic and up into the Bajocian without any significant variation. The form found in Turkey could well be *L. punctata* (J. Sowerby) of the Sineinurian and Pliensbachian, but it is not possible to be dogmatic about this and later forms are very similar.

*Cincta numismalis (*LAMARCK)

1819 — *Terebratula numismalis* Lamarck, p. 334.

1852 — *Terebratula numismalis* Lamarck, Davidson, p. 36.

1907 —*Cincta numimalis* (Lamarck), Buckman, p. 40.

Three or four specimens from Sorkun Yaylası appear to belong to this very variable species. Buckman (1907) erected no less than 19 species for specimens from a single quarry and there is no doubt that these would fall within the same sort of range of variation. Many species attributed to the closely related genus Zeilleria are also very close, for example *Z. subdigona* (Oppel). The whole complex is characteristic of the Sinemurian and Lower Pliensbachian. In the strictest sense, the name *Cincta numismalis* is usually associated with extremely compressed forms from the Lower Pliensbachian, but this form is not close enough to that to justify being pinned down so accurately.

Spiriferina sp.

The collection from Sorkun Yaylası includes one small dorsal valve of a Spiriferina. It is distinctive in having about 11 sharp costae, several of which bifurcate anteriorly. The specimen is too incomplete, however, to attribute it with confidence to any named species.

IV. STRATIGRAPHICAL PALEONTOLOGY AND PALEOECOLOGY

Seven faunas need to be considered.

1. The fauna from Terziler consisting solely of *H. amphitoma*. This species is confined to the Norian wherever it occurs and there is no reason to suppose it is any different in Turkey. The occurrence of the specimens in what seems to be an exotic block in a deep-water facies is in line with the hypothesis of the present author (Ager, 1965a) that this genus was probably adapted to life on a shallow, rocky sea-floor, where sediments did not normally accumulate. Brachiopods of this

type are only normally preserved under special circumstances, e.g. immediately below a transgressive sequence, in clastic dykes and in exotic blocks that have fallen into a deeper, accumulatory facies, such as the Kasımlar shales here.

2. The faunas from Banos Anamas and the Col de Banos. These are typified by the two species of Carapezzia, *Rhynchonella fissicostata, Austrirhynchia cornigera* and *Rhaetina* sp. These species are all highly typical of the Rhaetian stage. The most interesting by far is the aberrant rhynchonellid genus Carapezzia, which is only known at two other localities in the world. Like Halorella it is characteristically only preserved under special circumstances and was probably similarly adapted for life on a shallow, rocky sea floor.

It is interesting that Carapezzia occurs at the Col de Banos in a tectonized succession immediately adjacent to a flyschlike succession. In the Banos Anamas section, the Rhaetian fauna occurs in great abundance (albeit poorly preserved) in a well-bedded lumachelle type succession, which is practically all shelly material.

3. The fauna from Sorkun Yaylası bears a striking resemblance to the Brachiopod fauna previously described by the present author (Ager, 1959) from another Turkish locality—Yakacık near Ankara—although the fossiliferous limestone blocks in the shales differ completely from the red *«ammonitico rosso»* marls at Yakacık. The specimens of Aulacothyris and Cincta are almost identical in preservation as well as in morphology. The ammonite evidence at Yakacık suggested a slightly earlier age than was suggested by the brachiopods (i.e. early to late Sinemurian rather than Late Sinemurian to Late Pliensbachian). It is noteworthy that certain highly distinctive Late Pliensbachian forms, such as Prionorhynchia and *Zeilleria quadrifida* (Lamarck), are absent both at Yakacık and at Sorkun Yaylası. The balance of evidence therefore suggests a Sinemurian or early Pliensbachian age for this fauna.

It is interesting, however, that though the fauna, as normally developped, is one that is characteristic of shallow shelf environments, it occurs at Sorkun Yaylası in a flysch-like series adjacent to pillow-lavas.

4.The fauna from Barla Dağ collected by Gutnic was difficult to determine because of the preservation. They were, however, provisionally identified as follows:

Cuneirhynchia oxynoti (Quenstedt)

Piarorhynchia sp.

Tetrarhynchia ? sp.

Lobothyris ? sp.

These seem to indicate a Sinemurian or (at latest) an Early Pliensbachian age. They are comparable to the other Liassic faunas described here in.

5. The fauna from Menteşe, near Sandıklı collected by Gutnic is clearly older than the other Liassic faunas recorded here. The specimens all seemed to belong to the well-known species *Cakirhynchia calcaria* S.S. Buckman, which characterizes the Hettangian and lowermost Sinemurian. This is a rather «generalized», «ordinary-looking» rhynchonellid in external view, so too much dependence should not be placed on the identification, though serial sections appear to show the highly distinctive internal characters of the genus.

Two further faunas are not directly relevant to this paper, but are of interest:

6. A further brachiopod fauna was collected recently by Miss Füsun Alkaya in the Upper Sinemurian to Lower Pliensbachian of the Bilecik-Amasya district of Northern Turkey and was identified (by D.V.A.) as follows:

Cirpa kiragliae Ager (including variety *globosa)*
Cuneirhynchia, dalmasi (Dumortier)
Tetrarhynchia sp.
Lobothyris punctaia (J. Sowerby)
Auldcothyris anatolica (Vadasz)-
A. cf. *resupinata* (J. Sowerby)
Zeilleria perforata (Piette)
Spiriferina alpina (Oppel)
S. cf. *tumida* (von Buch)

This fits in perfectly with the age suggested by Miss Alkaya, but what was particularly remarkable was that the preservation and generally stunted appearance of the specimens is exactly like that of the Liassic fauna described earlier form Yakacık (Ager, 1959) and that described here from Sorkun Yaylası. In other words the Liassic brachiopod faunas are closely alike whether they be from northern, central or Southern Turkey and all seem to be living in a somewhat unfavourable environment. Alkaya refers to her fauna as occurring in an *ammonitico rosso* facies (appropriately since her name means red rock in Turkish!). From the containing lithologies generally it could well be that the brachiopods were living in deeper water than their normal optimum environment and could have been concentrated into their remarkable abundance by episodes of very slow deposition.

7. The final brachiopod fauna to be mentioned is one collected by Cazibe Sayar from Yozgat, east of Ankara in central Turkey. Differences exist about the true age of this fauna but jn the view of the writer, shared by Howard Brunton of the British Museum (Natural History) and by Christopher Walley of Swansea who first examined the collection is of late Triassic age. It is hoped that this fauna will be described at a later date but it seems to be remarkably similar to Norian and «Norian / Rhaetian» faunas described from the southern part of the Soviet Union, by Dagis (1963).

In this connection, Miguel Mancenido drew the writer's attention to a fauna described from the Crimea by Moiseev (1934, pl. figs. 1-32) and said to be mid-Jurassic in age. The forms were attributed to the genus Rhynchonellopsis and were certainly rhynchonellinids, which made a mid Jurassic age unlikely. In fact to the writer they are remarkably like the form described here as Carapezzia. In reply to an enquiry, Dagis kindly informed the writer that, though he did not think they were Carapezzia, Victor Kamyshan had collected more material at the same locality. He now attributed the brachiopods to Rhynchonellina and the containing rock to the early Jurassic. Whatever the precise determination, forms belonging to the Rhynchonellina complex are characteristic of the latest Triassic and earliest Jurassic ofsouthernmost Europe (just extending into Africa with other Euorpean forms in the Rif mountains at the westernmost end of the Mediterranean).

V. CONCLUSIONS

In the view of the present writer (D.V.A.) the Late Triassic and Early Jurassic braehiopod faunas so far described and seem from Turkey are wholly European in character. What is more, there is no record in Turkey of any of the highly distinctive Jurassic brachiopod faunas of the Middle East and East Africa. Most of these are admittedly later in age, so a direct comparison is not possible, though there is a little evidence of roughly contemporary faunas (e.g. that described by Hudson & Jeffries, 1961 from the Oman Peninsula).

So far as the exact age of the Late Triassic brachiopods is concerned, Dagis in his detailed work on Soviet faunas commonly lumped the Norian and Rhaetian together. Pearson (1977, p. 11) in his study of the Rhaetian brachiopods of Central Europe thought that most of Dagis's material was Norian in age. At the same time he claimed a quite distinctive assemblage of Rhaetian age including forms such as Carapezzia described her. He was, in fact, doubtful if any of Dagis's faunas was truly Rhaetian. The matter remains to be settled. However, the association of *Carapezzia gejeri, Austrirhynchia corrigera* and *Fissirhynchia fissicostata* is so characteristically Rhaetian in Europe that it is difficult to accept an early age.

VI. DISCUSSION

According to the present-day kownledge of the geology of Turkey, the northern mountain range, or Pontids, exhibits many stratigraphical and tectonic characteristics which differ markedly from the southern range, or Taurids, at least since the beginning of Mesozoic times. Although a precise limit cannot be accurately drawn between the two chains, its amplacement seems to coincide roughly with several major ophiolitic bodies in central Anatolia, which provide a convenient separation between the two chains.

To the north, the Pontids have suffered from the Hercynien orogeny, as shown by the thick cover of red sandstones and conglomerates which lies on the coal basin of Bartın (Westphalian) and the clear disconformity of Lower Triassic formations east of Istanbul (Tokay, 1952; Haas, 1968; Kaya, 1973; Assereto, 1972). The Mesozoic series above shows repeated tectonic phases between Lias and Late Cretaceous and Eocene time (Fourquin, 1975) which may be related to various erogenic crises already known in the Alps or the Carpathian mountains.

Distinctive facies have been recorded from the Pontids which may be related to remarkably similar ones in the Mesozoic formations either in Southern Europe or Northern Iran (Elbourz). A good example is given by the thick volcano-detritic formation containing several coal seams of Liassic age, which appears almost unchanged from Gresten in Austria to Gümüşhane in Eastern Turkey, and to Semsak in Iran (Brunn, 1960; Bergougnan, 1975; Stöcklin, 1968: Stampfli, 1978). It is not surprising, therefore, that identical brachiopods faunas, all of European type, have been extracted all along the trend of this formation (Ager, 1970), including near-by localities such as Yozgat, Yakacık & Bilecik (Fig. 1). Faunal similarities also apply to the Ammonites of Late Jurassic age, which clearly indicate their European origins (Enay, 1972).

Qn the other hand, the Taurids do not contain evidences of the Hercynian orogeny and its subsequent phases which characterise the European border of the Alps. The Taurids are related westwards to the peri-Adriatic chains of Greece and Yugoslavia (Hellenids and Dinarids) whilst to the east, the Taurids pass into the Zagros Mountains around the Arabian peninsula. The thick deyelopmejit of undisturbed Mesozoic carbonates in the relatively autochthonous external zones of the Taurids may thus be correlated to many similar series in Western Greece and Yugoslavia, in Southern Italy, in Iran, Lebanon and Syria (Brunn, 1956, 1957; Aubouin, 1960, 1973, 1976) which in turn may be regarded as the northern extension of the Arabo-African continental platform (cf. Ricou & al., 1976).

What is more, in the Taurids, numerous allochthonous units, including gigantic ophiolitic nappes have come from the North and now lie upon the more external carbonate platforms of Mesozoic to Tertiary age. Careful geological investigations carried out in the sedimentary allochtonous units have repeatedly shown that the purely pelagic series and basic effusive volcanics (pillow-lavas) never appeared before Mid to Late Triassic times (Brunn & al., 1971) suggesting that a major facies differentiation from the formely neritic formations took place at this period, and may be considered as opening of a break which ultimately led to the Mosozoic Tetliys (Argyriadis 1975).

The distribution of the ophiolitic massifs and their closely related pelagic series of Triassic or younger age in Anatolia strongly support the separation of the Taurids from the Pontids as early as Middle Trias. In that way, the Pontids would belong to the European rim of the Eurasian platform from which no major tectonic accident can separate them, whereas the Taurids clearly are independent from the Eurasian platform, although their link to the northern part of the African platform is not fully demonstrated.

Faunal evidence partly supports this image, with presence of various genera in the Taurids which are well known from the Mesogean basin but not from the European platform (Hirsch, 1976; Enay, 1976).

In constrat with this view, the Brachiopods studied here have strong European affinities, which are most surprising in the Taurids.

It is difficult to be dogmatic about this because one just does not know, for example, what an «African» Late Triassic brachiopod fauna would look like, since none has been described. However, one can be dogmatic in saying that not one distinctively «African» Mesozoic brachiopod has been found so far in Turkey. The Triassic forms are all close to those known from «Tethyan» parts of Southern Europe, but the Jurassic faunas are close to those of extra-alpine Europe.

This may be explained by various hypotheses:

The most obvious one concerns the actual place of the limit between Taurids and Pontids, which still is conjectural in most of the Turkish territory, except near Erzincan ((Bergougnan, 1977), so that large fragments of the Pontids might have been thrust onto the Taurids (and inversely) without having been already properly identified (Bailey & McCallien, 1953). Localities 3 & 6 might indeed belong to distinct tectonic units of more northern origin (Gutnic, 1977). However, all the other localities undoubtedly belong to the Taurus chain, and contain typical Tethyan faunas at various levels (from Triassic to Eocene) (Brunn & al., 1971).

An alternative hypotheses to explain the distribution of European brachiopods in the Taurids as well as in the Pontids might be related to their fixed mode of life: having evolved from a common Palaezoic stock which appears to be evenly distributed in the Pontids and in the Taurids (Kırağlı-Ünsalaner, 1941; Blumenthal, 1963; Haas, 1968; Dil, 1975), the Triassic faunas were still probably uniformly scattered in Turkey, when the break of the new-forming Tethys began to separate northern from Southern Turkey, and progressively grew wider between the (future) Pontids and Taurids. Not until the gap had become large enough, would be fixed faunas have evolved differently on both margins of the Tethys. This type of «explanation» applies well to the Gibraltar strait where the gap between Europe and Africa never seems to have been large, and where accordingly the faunas are closely comparable in Mesozoic times from Southern Spain to the Rif and Atlas mountains; it is proposed here that a similar pattern occurred between Pontids and Taurids during Triassic and Liassic periods. Later on, the gap having sufficiently increased, the two populations independently evolved on the two sides of the Tethys.

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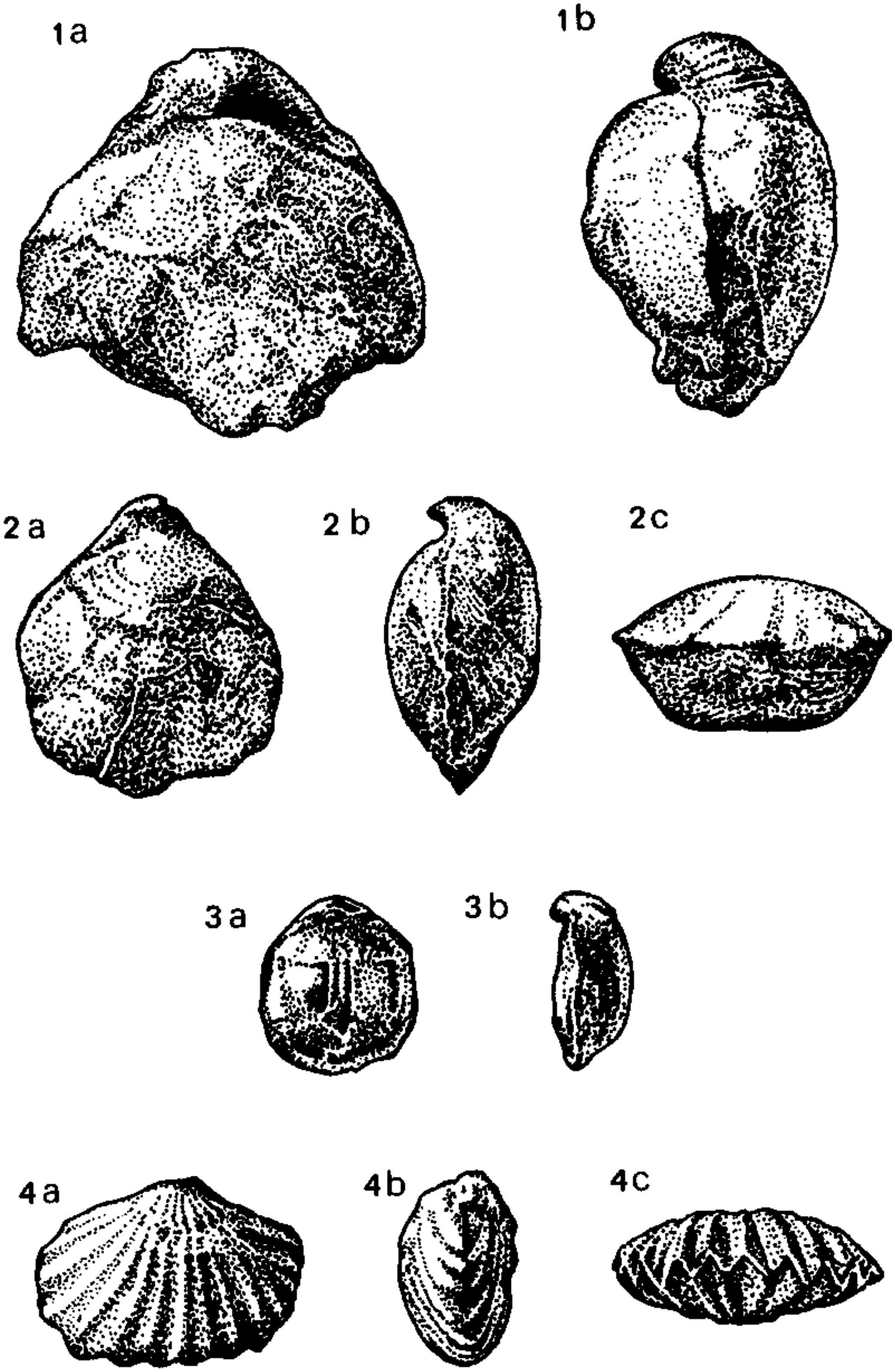
1a
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2 b
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4 b
4c

Fig. 1 a-b - *Carapezzia globosa* (Carapezza and Schopen).

Dorsal and lateral views; Rhaetian, Col de Banos. XI.

Fig. 2 a-c - *Carapezzia geyeri* (Bittner).

Dorsal, lateral and anterior views; Rhaetian, west side of Anamas Dağ, south of Lake Eğr

Fig. 3 a-b - *Carapezzia* sp.

Juvenile showing muscle scars; dorsal and lateral views; Rhaetian, same locality. XI.

Fig. 4 a-c - *Halurella amphituma* (Bronn).

Dorsal lateral and anterior views; Norian, near Terziler. XI.

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LES ALGUES DU CRETACE INFERIEUR DES SERIES DE TYPE BEY DAĞLARI
(TAURIDES OCCIDENTALES, TURQUIE)

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ABSTRACT. — Description of *Pseudoepimastopora pedunculata* n.sp., *Pseudotriploporella imecikae* n.g., n.sp. The lower Cretaceous of the Bey Dağları serie (Western Taurides, Turkey), is well known by its association of abundant Algae, and by its poor content in Foraminifera. The fades are of neritic type, infra to supra tidal with bird eyes vug, geopetal sediments and stomatolites. Some associations of Algae are described here and their stratigraphical position, well known in other places all around the Mediterranean, is precised.

I. PRESENTATION GENERALE (A.P.)

1. Introduction

Dans les series que l'on peut rattacher au type Bey Dağları (Poisson, 1977), le Cretace inferieur est maintenant connu en plusleurs endroits. Il presente constamment des fades neritiques de milieu littoral (Poisson, 1974 et 1977; Akbulut, 1977), pauvres en microfaunes caracteristiques mais relativement riches en Algues.

Dans les series d'Akseki et de Beyşehir (Monod, 1977), le Cretace inferieur se presente sous des fades tres semblables, aussi demunis en reperes stratigraphiques.

C'est donc a l'echelle des Taurides que se pose le probleme de la stratigraphie du Cretace inferieur. L'etude des flores d'Algues permet d'apporter une reponse, au moins partielle, a ce probleme.

Dans le flanc oriental du massif des Bey Dağları, la coupe d'İmeciksusuz s'est revelee particulierement interessante par sa continuite et la richesse de ses flores d'Algues (Poisson, 1977), elle nous servira d'exemple. Quelques echantillons provenant de l'unite de Sütçüler (Akbulut, 1977), (dans les ecailles de la rive gauche de l'Aksu), ont ete choisis a titre d'exemple complementaire du fait de leur richesse en Algues.

2. La coupe d'İmeciksusuz

A. Localisation. — Cette coupe est situee dans le flanc oriental du massif anticlinale des Bey Dağları. Elle apparait en faveur d'accidents, dont une grande faille qui a effondre la voute anticlinale. Apres un redoublement a la base, du a une faille secondaire, la serie est continue sur environ 900 m de denivelee, et ne comporte que du Cretace inferieur et du Cenomanien.

B. Facies. — Il s'agit d'une serie monotone de calcaires regulierement lites, sans reperes lithotogiques nets. Le passage Cretace inftrieur - Cenomanien est indiscernable. Il en est de meme pour le passage Malm - Cretace inferieur dans les autres coupes. C'est la «serie comprehensive mesozoique» des anciens auteurs (Altınlı, 1944; Blumenthal, 1960-1963).

Les microfacies sont varies dans le detail mais ils se ramanent a 2 types principaux qui se repetent plus ou moins regulierement tout au long du profil, soulignant la rythmicite de la sedimentation,

Le ler type, correspond a des facies franchement marins, littoraux, de milieu faiblement agite:

— Vases calcaires fines (micrites) a ostracodes, foraminiferes et algues,

— Sables vaseux a ciment de calcite spathique, a debris d'algues et foraminiferes (packatones, wackestones).

Le 2 eme type, correspond a des facies de milieu tendant au confinement, et emergeant temporairement:

— Vases compactes sombres, azoiques, a fines laminations sinueuses (traces de voiles algaires de type stromatolitique ?).

— Vases sombres a pellet, pellets fecales (Favreines), et a structure oeillee evoquant des fentes de retrait horizontales, avec, ou sans, rempllssage secondaire.

Ces sediments se sont, deposes dans un. milieu tres peu profond a emersiont temporaires. C'est surtout dans ce type de facies que l'on observe une (lolomitisation plus ou moins prononcee (quelquefois totale, quelquefois reduite a des nuages de rhomboedres). Cette dolomitisation est certainement a mettre en relation, avec le confinement du milieu et sa tendance a l'emorsion.

L'alternance de ces 2 types de facies, sur pres de 1000 m d'epaisseur, atteste d'une subsidence active de la plate-forme taurique a cette epoque.

3. L'unite de Sütçüler

L'echantillon 133 provient d'une coupe de l'unite de Sütçüler. Cette uniti. constitue l'unite carbonatee principale des ecallies de rive gauche de l'Aksu, empilees a la fin du Miocene sur la molasse tortonienne. Cette unite, par sa serie mesozoique neritique devenant pelagique au Senonien superieur, presente de grandes ressemblances avec les series de type Bey Dağları, Le Create inferieur y a ete mis en evidence par des flores d'Algues (Akbulut, 1977).

II. ETUDE DES ALGUES (M. J.)

Cette etude porte sur le materiel contenu dans trois echantillons:881 E, 853 E et 133 A, qui-sont replaces par les figures 1 et 2 dans la serie stratigraphique de la region.

1. Associations contenues dans les differents echantillons

A. Echantillon 881 E

Microflore: *Salpingoporella melitae* Radoicic (Pl. IV, fig. 8), 5. *muehlberghii* (Lorenz) (Pl. I, fig. 5), *Ethelia alba* (Pfender) et *Thaumatoporella parvovesiculifera* Raineri; ces organismes, bien connus, ne sont que mentionnes ici. *Salpingoporella dinarica* Radoicic (rares), *Cylindropo-*

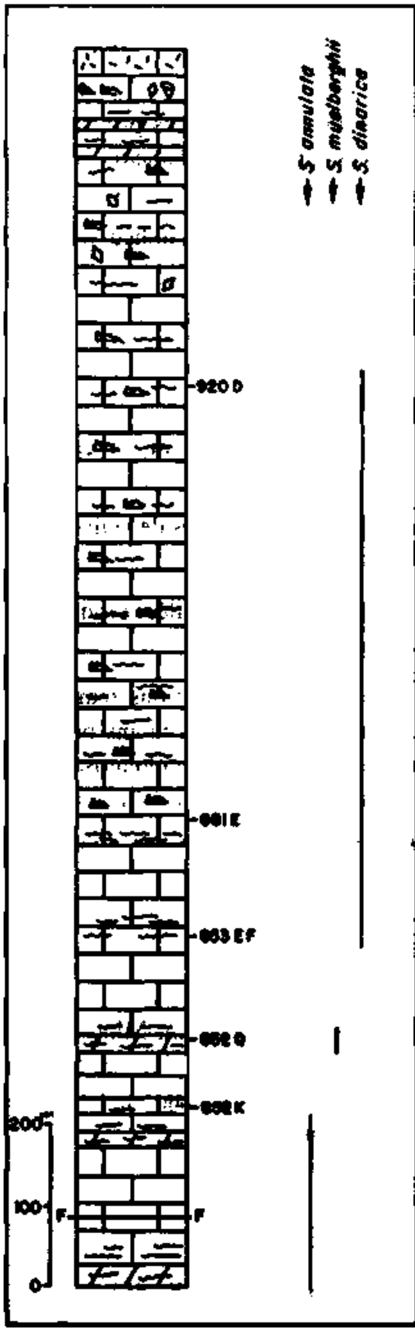


Fig. 2 - Coupe d'imeciksusuz.

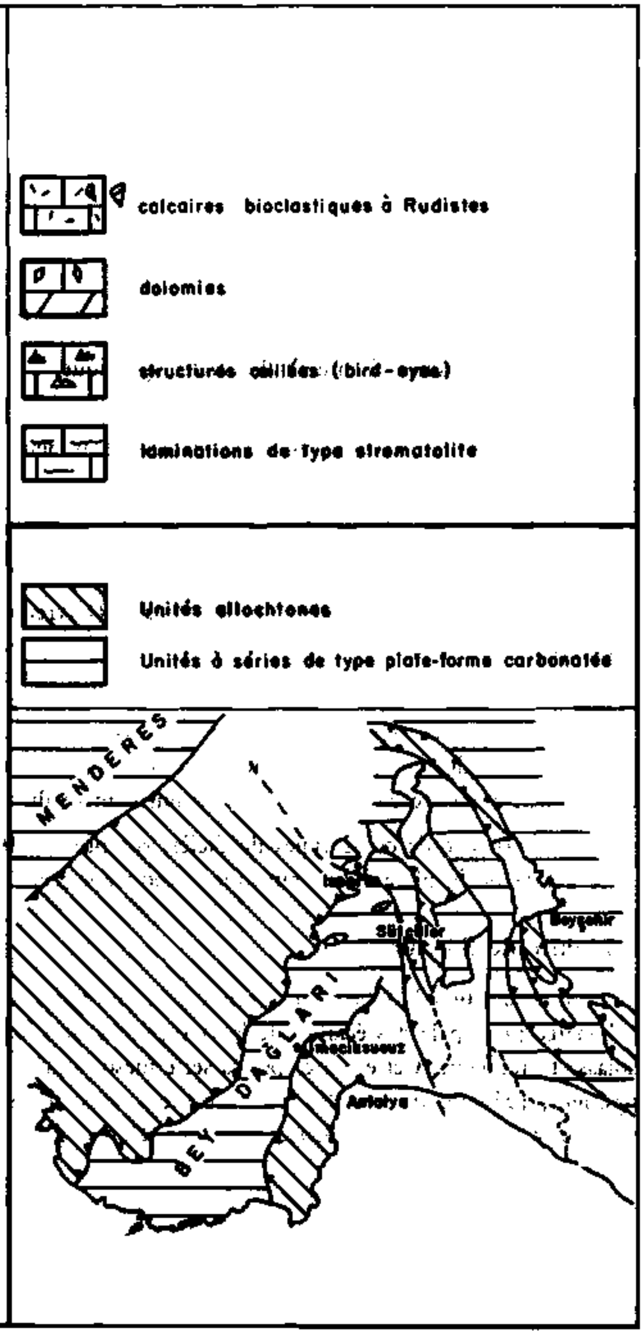


Fig. 1 - Schéma de localisation.

rella cf. *elitzae* Bakalova, *Pseudoepimastopora pedunculata* n. sp. *,Triploparella* cf. *marsicana* Praturlon, ? *Triploporella* sp., *Pseudotriploporella imecikae* n. g., n. sp. Ces especes peu connues ou nouvelles seront plus particulierement etudiees et figurees dans ce travail.

Microfaune (determination de Eric Fourcade)[1]: *Orbitolina* sp., *Nezzazzata* sp., *Pictidocydammina* sp. organisme evoquant *Hensonia lenticularls* (Henson), *Cuneoliria scdrcellai* de Castro.

B. Echantillon 853 E. — Il renferme en abondance *Salpingoporella dinarica* Radoicic a l'exclusion de tout autre organisme, sauf **de** tres rares Miliolides et debris d'Ostracodes.

C. *Echantillon 133 A*

Microflore:S. dinarica Radoicic, 5. *istriana (Gusic) Acroporella of, radoicicae* (Praturlon), ?*Cylindroporella* sp. *Suppiliumaella polyreme* Elliott, et une Sp, A.

Microfaune (determ. E. Fourcade): *Cuneolina scarcellai* de Castro

2. Remarques

— Les associations algaires sont riches, sauf evidemment pour l'echantillon 853 E, Outre une espece et un genre nouveaux, elles renferment des algues, a notre connaissance, n'avaient jamais, auparavant, ete citees et figurees en provenance de Turquie *(Salpingoporella dinarica, S. melitae, S. muehlberghii, S. istriana, Cylindroporella elitzae, Acroporella radoicicae, Triploporella marsicana).*

Il peut etre intoressant de faire remarquer que ces associations rappellent celles signalers dans d'autres regions a la meme epoque et particulierement en Italie et ea Yougoslavie.

La microfaune associee, assez pauvre et mal conservee, permet cependant, selon E. Fourcade qui l' a examinee, d'attribuer ces echantillons a l'Aptien (peut etre meme a l'Aptien superieur). Ce que l'on sait par ailleurs de la repartition des especes de Dasycladacees citees ici ne contredit pas cette indication stratigraphique.

3. Etude micropaleontologique des Dasycladacees

Salpingoporella dinarica RADOICIC, 1959

(Pl. I, fig. 1 et 2; Pl. V, fig. 8 (pars.))

Cette algue se caracterise bien par sa forme, ses dimensions et surtout sa calcification de type original chez les organismes rapportes aux Dasycladales.

Dimensions (en mm) (specimens de l'Ech. 853 E settlement):

	Moyenne	*Nombre de mesures*	*Minimum et maximum observes*
D	0,2	89	0,1 a 0,33
d	0,11	89	0,04 a 0,22
d/D			0,40 a 0,81
W		12	6a 16
h 18		0,02	a 0,04

Il semblerait que l'on puisse distinguer dans nos specimens deux types, mais de façon peu nette:

— Le premier, dans lequel le rapport d/D est environ egal a 1/2, correspond a des algues a la paroi assez forte. Le second, ou d/D est de l'ordre de 2/3, rassemblerait des algues a paroi plus mince. Mais il faut souligner que les autres caracteres, morphologie, dimensions, calcification sont identiques et que de plus, entre ces deux «types» il-existe tous les intermediaires.

Cylindroperella cf. elitzae BAKALOVA, 1971

(Pl. I, fig. 9 a 11)

Nous rattachons nos specimens au genre Cylindroporella bien que nous n'ayons jamais pu les observer qu'en coupes transversales plus ou moins obliques. En effet celles-ci permettent quand *mime* de se rendre compte que certe algue possede deux types de ramifications de premier ordre situes sur un meme verticilfe. Les ramifications «fertiles» semblent etre portees par un court pedoncule (cf. Pl. I, fig. 9). Les ramifications «steriles» s'inserent entre les ramifications «fertfles» et sont, de ce fait, retrecies dans leur partie moyenne. Elles s'elargissent dans leurs parties distale et proximale. Nous n'avons pas observe de ramifications secondaires.

Dimensions (en mm):

	Moyenne	*Nombre de mesures*	*Minimum et maximum observes*
D	*1*,35	8	0,9 a 18
d	*0,4*	7	0,26 a 0,65

W des ramifications «fertiles»: 8 (mais deux evaluations seulement)

Ramifications «fertiles»: Grand diametre: 0,33 (10 mesures)

Petit diametre: 0,25 (7 mesures)

Ramifications «steriles»: Longueur: 0,6

Diametre: a la base 0,2
a la partie mediane 0,1
au sommet 0,22

Discussion: On sait que la differenciation des especes du genre Cylindroporella repose essentiellement sur des criteres dimenslonnels. Par ailleurs nous, n'avons pu observer que des sections transversales. En tenant compte de ces remarques il semble que parmi les differentes especes du genre Cylindroporella ce soit de C. *elitzae* Bakalova 1971 que l'on puisse rapprocher le plus les specimens que nous decrivons ici.

Pseudoepimastopora pedunculata n. sp.

(Pl. II, fig. 1,2,3,6,9; Pl. IV; fig. 2 (pars.) et Pl. VI, fig. 3)

Holotype: Pl. II, fig. 2

Diagnose: Thalle tubulaire faiblement calcifie, a tres importante caviteaxiale, euspondyle(?) la base, fortement retrecie forme pedoncule; un seul ordre de courtes ramifications globuleuses est conserve; presence eventuelle d'un cylindre central.

Description: Forme generate: il s'agit d'une algue d'assez grande taille, de forme tubulaire dont le sommet est arrondi et la base fortement retrecie forme une sorte de pedoncule.

La cavite axiale: Son importance pose une serie de questions: sur certains specimens (cf. PI. II, fig. 1 a 3) la cavite axiale semble correspondre au cylindre central (le contour interne de la partie calcifiee est tres regulier) et dans ce cas l'algue serait caracterisee par l'existence d'un cylindre central tres important par rapport au diametre externe de l'Algue et par de tres courtes ramifications de premier ordre seulement. Cependant d'autres specimens, beaucoup rnoins frequents (cf. PI. IV, fig. 2; PI. I, fig. 2) paraissent permettre de supposer l'existence d'un cylindre central fossilise au centre de la cavite axiale. Cela impliquerait, de plus, que les ramifications que Ton observe ont de fortes chances de ne pas etre de premier ordre, mais d'un ordre superieur difficile a preciser d'ailleurs en raison de Pabsence totale de ramifications conservees entre le cylindre central et l'enveloppe externe calcifiee.

Les ramifications: les ramifications du seul ordre qui soit conserve sont courtes et globuleuses, au moins dans la partie moyenne du thalle (cf. PI. VI, fig. 3). Les coupes tangentielles que nous avons pu observer n'interessent que la partie basale de Palgue. Elles montrent des ramifications disposees en verticilles et alternant d'un verticille a l'autre (cf. PI. II, fig. 2 et 3); cependant sur les fig. 6 et 9 de la meme planche, les ramifications se disposent en rangees, disposition qui n'est pas sans rappeler celle des Heteroporelles.

Dimensions (en mm):

	Moyenne	*Nombre de mesures*	*Minimum et maximum observes*
L			11,2
D	1,4	23	0,88 a 1,6
d	1,1	23	0,56 a 1,42
d/D	de,l'ordre de 80 %		
W	de 20 a 25		
p	0,08 a 0,1		
h	0,05 a 0,1 (mais peu de mesures car nous n'avons dispose que de rares coupes tangentielles)		

Discussion: On peut comparer nos specimens a *Epimaslopora* (Pia, 1923), Johnson, 1946, *Pseudoepimastopora* Endo 1960 et *Harlanjohnsotiella* Elliott 1968,genres ou la faible calcification pfripherique implique une grande cavite axiale et un seul ordre de ramification observable.

De ces trois genres, seuls les deux derniers sont (ou peuvent etre), euspondyles, et ont des pores globuleux, au moins, sur une partie de leur longueur.

Selon G.F. Elliott (1968), *Harlanjohnsonella* est caracterisee par une structure annulaire qui le differencie des deux autres 1. Les nombreuses sections longitudinales de nos specimens ne montrent jamais cette structure annulaire. L'espece decrite ici est donc a rapporter au genre *Pseudoepimastopora* Endo 1960 dont la diagnose generique precise cependant que le thalle est relativement court et elliptique. La seule espece mesozoique de ce genre, *P. jurassica* Endo 1960 n'est decrite que sur des fragments ce qui rend la comparaison difficile, c'est pourquoi nous proposons une nouvelle espece.

Triploporella cf. *marsicana* PRATURLON, 1964

(PI. V, fig,. 1)

Description: Le thalle cylindrique et a cavite axiale relativement grande possede deux ordres de ramification.

Les ramifications primaires, perpendiculaires a 1'axe du thalle ne sont pas calcifiees sur toute leur longueur; de diametre sensiblement constant elles donnent naissance a leur extremite distale a 4 ramifications secondaires disposees tres regulierement, plus courtes, et s'elargissant legerement vers la surface externe du thalle.

Dimensions (en mm):

L: env. 10 (mais il ne s'agit que d'une coupe longitudinale oblique)
D: 2.2
p : en moyenne de 0.15 a 0.08
p': env. 0,09 (dans leur partie la plus large)
1' : env. 0.15

Discussion: L'allure generale nous parait permettre de rapprocher nos specimens de *T. marsicana* Praturlon malgre quelques differences morphologiques (inclinaisons des ramifications sur 1'axe), dimensionnelles et surtout 1'absence de "spores".

? *Triploporella* sp.

(Pl. IV, fig. 2 (pars.), 3.4 et 6; Pl. V, fig. 3.6 et 7; Pl. VI, fig. 4)

Description: La forme generale du thalle: il s'agit d'une algue de forte taille en forme de massue (cf. PI. IV, fig. 2); la calcification n'atteignant pas le cylindre central, la cavite axiale est importante.

Les ramifications: Il existe deux ordres de ramifications:

— Les ramifications primaires, a peu pres cylindriques et tres nombreuses par verticille, alternent d'un verticille a 1'autre. Leur position par rapport a 1'axe n'est pas identique : elles sont soit perpendiculaires, soit inclinees vers le haul on vers le bas (cf. PI. IV, fig. 2 et 3; et PI. V, fig. 3).

— Les ramifications secondaires au nombre de 4 pour chaque ramification primaire ne se disposent pas de façon reguliere; elles s'elargissent regulierement vers 1'exterieur (cf. PI. IV, fig. 4).

La calcification: On rencontre systematiquement dans nos specimens deux types de calcification : d'une part, vers la surface du thalle, une enveloppe continue de contour interne irregulier montrant les ramifications constitutes de cristaux hyalins relativement grands. D'autre part, entre cette enveloppe et la cavite axiale, une cristallisation en petits cristaux jaunatres interesse non seulement les parois de 1'algue (soulignee par une trace noiratre) mais aussi Pinterieur et 1'exterieur des ramifications et meme parfois se superpose a 1'enveloppe hyaline (cf. PI. VI, fig. 4).

Dimensions (en mm):

L: 7.2 (mais 1'algue n'etait pas entiere)
D: de 2..4 a 3.4
d : de 1.6 a 2.2
W: 42 (mais une seule mesure a pu etre faite)

p : de 0.15 a 0.22
1 : de 0.4 a 0.6
p': de l'ordre de 0.1
1': de l'ordre de 0.12

Discussion: Par son allure generale nos specimens rappellent les Triploporella (grande taille, importance relative de la cavite axiale, forme en massue, ramifications de deux ordres, grand nombre de ramifications primaires par verticilles, verticilles tres serres).

Ils s'en differencient par le fait que les ramifications de premier ordre ne sont pas toutes perpendiculaires (ou a peu pres) a l'axe du thalle, par la calcification originale, par l'absence de «spores» dans les ramifications de premier ordre.

Pseudotriploporella n. g.

Generotype: *Pseudotriploporella imecikae* n. sp.

Diagnose: Genre a Phabitus[2] «triploporelliforme» mais qui se differencie du genre *Triploporella* (Steinmann, 1880) emend Bassoullet *et al.,* 1978 par le fait qu'il ne possede que des ramifications primaires.

Pseudotriploporella imecikae n. sp.

(PI. III, fig. 2, 3, 5 et 6; PI. V, fig. 4)

Holotype: PL III, fig. 5. Ech. 881 E 4

Localite type: Coupe d'lmeciksusuz (Description in A. Poisson 1977).

Niveau type: Aptien (?)

Diagnose: Pseudotriploporella dont les ramifications, de premier ordre, se rattachent au cylindre central par un etroit pedoncule se distinguant nettement du reste de la ramification.

Description: Forme generale du thalle: II s'agit d'une assez grande forme, cylindrique, non segmentee, a sommet arrondi (cf. PI. III, fig. 5 et 6).

Les ramifications: II n'existe que des ramifications primaires, perpendiculaires a l'axe du thalle (sauf evidemment a la partie sommitale). Les ramifications sont tres nombreuses par verticilles et ceux-ci tres serres le long de l'axe ce qui donne aux sections des ramifications une allure quadrangulaire. Leur extremite distale est arrondie (cf. PI. III, fig. 3), mais leurs dimensions restent sensiblement constantes sur toute leur longueur. Elles sont reliees au cylindre central par un etroit pedoncule situe a leur partie inferieure (cf. Pl. III, fig. 5).

Dimensions (en mm):

	Moyenne	*Nombre de mesures*	*Minimum et maximum observh*	
L		2	6.6	et 6.4
D	3.2	12	2.8	a 4.0
d	1.4	7	1.2	a 1.8
p	0.26	21	0.26	a 0.3
1		0.6		a 1.0
W	de l'ordre de 30 mais il ne s'agit que d'une evaluation.			

Pedoncule: p de 1'ordre de 0.08 Seules quelques mesures ont ete faites.
1 de 1'ordre de 0.2

Discussion: Par sa forme generale, les caracteres des ramifications et des verticilles, cette algue se rapproche des especes du genre Triploporella. Elle s'en differencie nettement par la presence de ramifications seulement de premier ordre et aussi par le fait que nous n'avons jalmais trouve dans ces ramifications de «spores» si frequemment rencontrees chez les Triploporelles. Ces differences nous ont paru pouvoir justifier la creation d'un houveau genre.

Salpingoporella istriana (GUSIC), 1966

(PI. I, fig. 6 et 7)

Description: Thalle cylindrique ne possedant que des ramifications de premier ordre disposees en verticilles et alternant d'un verticille a 1'autre. Le diametre des ramifications, petit par rapport a leur longueur reste a peu pres constant sur toute leur longueur et ne s'elargit que tres faiblement a I'extrenite distale. Inelinees d'environ 60° par rapport 1 1'axe du thalle a leur base, les ramifications se rapprochent de Phorizontale pres de la surface erterne.

Dimensions (en mm):

	Moyenne	*Nombre de mesures*	*Minimum et maximum observes*
L			3.4
D	0.55	25	0.45 a 0.85
d	0.20	23	0.10 a 0.35
W	24		14 a 36
h	0.06/0.07	14	0.05 a 0.09
p	0.03 (base)	0.02	a 0.05
1	0.15		

Discussion: Parmi les Salpingoporella de taille rektivement faible et anombre de ramifications par verticille assez grand *(S. pygmaea, S. johnsoni, S. tosaensis, S. istriana)* c'est a cette derniere espece que nous rattachons nos specimens bien que les caracteres dimensionnels differents un peu.

Acroporella cf. *radoicicae (* PRATURLON), 1964

(PL II, fig. 4,5,7 et 8)

Description: Forme generale: D'assez grande taille et cylindrique, le thalle possede une cavite axiale de diametre relativement important qui semble, elle aussi, cylindrique, bien que ses limites ne soient pas toujours tres nettes.

Les verticilles: Les ramifications de premier ordre se rassemblent en verticilles bien separes les uns des autres (h superieur a p) repar-tis regulierement le long de 1'axe; les ramifications de premier ordre alternent d'un verticille a 1'autre (PI. II, fig. 8).

Les ramifications: Celles de premier ordre, obliques par rapport a 1'axe du thalle et assez longues, ne s'elargissent que tres faiblement a partir de leur extremite proximale; leur extremite distale parait renflee (cf. PI. II, fig. 5). Les ramifications secondaires se detachent nettement, au nombre de 4, a l'extremite distale de chaque ramification primaire; tres courtes par rapport a ces dernieres elles se disposent de façon tres reguliere (cf. PI. II, fig. 8).

Dimensions (en mm):

	Moyenne	*Nombre de mesures*	*Minimum et maximum observes*
L			6
D	1,9	13	1,36 a 2.4
d	0,9	11	0,44 a 1,2
W	superieur a 25 (il s'agit d'une evaluation)		
h	0,22	17	0,15 a 0,25
p	0,12	14	0,06 a 0,2
l	0,45	8	0,4 a 0,5
p' - l'	0,05		

Discussion: Les differents caracteres morphologiques evoques ci-dessus nous conduisent a rapprocher nos specimens du genre *Acroporella* (Praturlon) 1964, emend Praturlon et Radoicic 1974. Rappelons que, parmi les trois especes actuellement decrites comme appartenant a ce genre, seule *A. radoicicae* possede les caracteres generiques etablis par l'emendation de A. Praturlon et R. Radoicic (1974) (cf. la discussion, in J.P. Bassoullet *et al,* 1978).

Nos specimens possedent des caracteristiques dimensionnelles nettement differentes de celles de *A. radoicicae,* mais cela ne nous semble pas justifier la creation d'une nouvelle espece.

Signalons en outre que B. Sokac et L. Nikler ont decrit en 1975 sous le nom de *Triploporetta issaensis* une algue a laquelle nos specimens ressemblent beaucoup (cf. en particulier leurs illustrations PI. Ill, fig. 1 a 4). Cependant nos specimens ne possedent ni l'elargissement a l'extremite proximale des ramifications de premier ordre, ni les «spores» (rares) dans ces memes ramifications qui sont caracteristiques de *T. issaensis* selon ses auteurs.

? *Cylindroporella* sp.

(PI. I. fig. 3, 4 et 8; PI. III, fig. 8 et PI. V, fig. 8 (pars.))

Description: Les specimens que nous designons sous ce nom possedent un thalle cylindrique, des ramifications a peu pres spheriques disposees en verticilles et alternant d'un verticille a l'autre; c'est a dire des caracteres qui permettraient de les attribuer au genre Cylindroporella.

Cependant nous n'avons jamais observe qu'un seul type de ramification et non les deux types qui caracterisent le genre Cylindroporella. Ou bien dans nos specimens, les ramifications «steriles» n'ont pas ete fossilisees; ou bien ils ne possedaient qu'un seul type de ramifications en ampoules. La disposition tres serree, que l'on observe par ex. sur l'exemplaire de la fig. 4 de la Pl. I, pourrait conduire a cette derniere interpretation.

Dans ce cas nos specimens ressembleraient au genre *Sarfatiella* Conrad et Peybernes 1973 ou *Holosporella* Pia 1930 (cf. la discussion du genre *Sarfatiella* in J.P. Bassoullet *et* ., 1978). Mais nous n'avons pas pu etablir sur nos specimens, au demeurant assez rares, si ces ampoules communiquaient avec le cylindre central.

En conclusion nous preferons rapporter, avec doute, ces exemplaires au genre Cylindroporella, Dimensions (en mm) (peu de mesures out pu etre faites):

D : de 0.35 a 0.85
d : de 0.25

Ampoules: 0,15 / 0,20 sur 0.23 / 0.25

Sp. A
(PI. IV, fig. 7 et PI. V, fig. 2)

Descript ion : Algue de forte faille, apparemment cylindrique et bien calcifiee. Euspondyle, elle ne possede que des ramifications de premier ordre, obliques par rapport a 1'axe du thalle qui s'elargissent regulierement a partir de leur extremite proximale. Ces ramifications, bien que nombreuses par verticille, ne sont pas adjacentes.

Dimensions: Peu de mesures ont pu etre effectuees, cette algue etant rare.

L: 2.6 (mais il nc s'agit que d'un debris)
D: 2.4 et 2.3
d: 0.68 et 0.9
p: a la base de 1'ordre de 0.05 pres de 1'extremite distale de 0.16 a 0.20
1: 0.8

Discussion: Cette algue se differencie nettement des genres Triploporella, Acroporella, Montenegrella, Suppiluliumaella etc., car elle ne possede pas de ramifications secondaires. Elle se distingue aussi du genre que nous creons ici, Pseudotriploporella par le nombre de ramifications par verticille et la disposition beaucoup moins serres de ses verticilles. Nos specimens, trop peu nombreux, ne permettent pas une etude exhaustive de cette espece qui parait nouvelle.

Suppiluliumaella polyreme ELLIOTT, 1968
(PL III, fig. 1,4,7; PL IV, fig. 1,5 et PL V, fig.5)

Description: Forme generate: II s'agit d'une algue de grande taille caracterisee par deux ordres de ramifications. La calcification qui ne semble pas atteindre le cylindre central ne parait pas etre identique chez tous les specimens, parfois le thalle, y compris la cavite axiale, est entierement recristallise.

Les ramifications: Les ramifications primaires sont obliques par rapport a 1'axe du thalle; fines a leur extremite proximale, elles s'elargissent brusquement a leur extremite distale pour donner naissance a des ramifications de deuxieme ordre, an nombre de 3 ou 4 (?), mal separees des ramifications primaires.

Les ramifications secondaires semblent conserver un diametre constant sur toute leur longueur, ou s'elargir, elles aussi, vers la surface du thalle.

Dimensions :

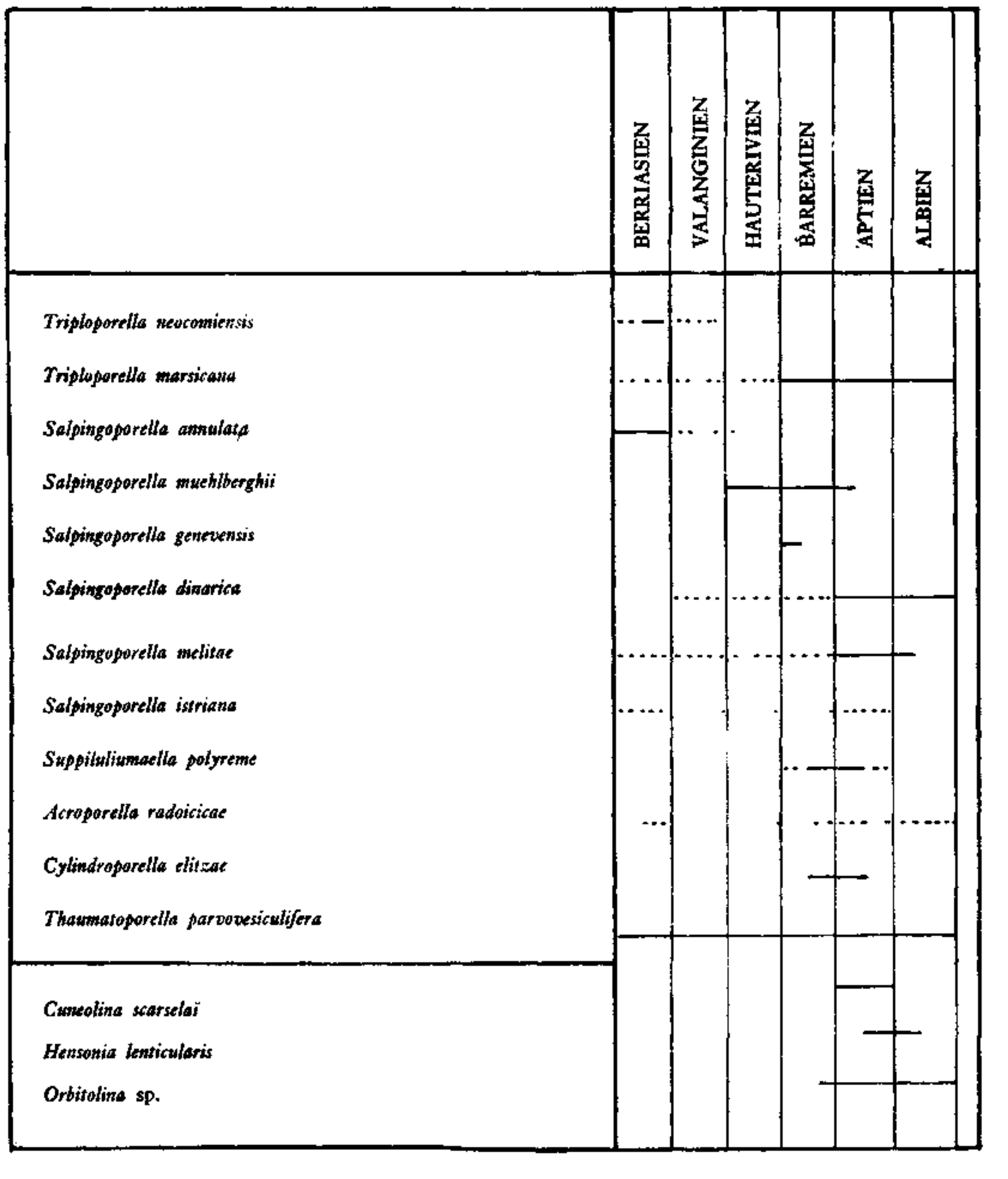
	Moyenne	*Nombre de mesures*	*Minimum et maximum observes*
D	1.5	9	1,4 a 1.68
d	0.6	8	0.4 a 0.8
W	(evaluation) entre 20 et 25		
p	0.05 (a la base)		
p'	0.05		
1'	0.23		
h	0.17		

Discussion: L'inclinaison des ramifications de premier ordre par rapport a 1'axe du thalle, la presence de ramifications secondaires mal separees ties ramifications primaires nous font rapporter nos specimens au genre *Suppiluliumaella* Elliott, 1968 et en particulier a 1'espece S. *polyreme*.

Notons que cette attribution nous semble douteuse pour l'exemplaire figure Pl. IV, fig. 1, calcifie d'une maniere homogene et dont les ramifications secondaires sont beaucoup moins visibles, mais pent etre ne s'agit - il la que d'un phenomene d'usure.

Par ailleurs certains exemplaires, par exemple celui figure Pl. III, fig. 1, pourraient etre interpretes comme appartenant au genre *Crinella* Sokac et Nikler 1973. L'elargissement des ramifications primaires sur lequel prennent naissance les ramifications secondaires, parait avoir une forme de calice (caractere generique important du genre Crinella). Mais cet aspect n'est - il pas du simplement a l'angle selon lequel est coupe cet elargissement ?

Tableau de répartition stratigraphique des algues et foraminifères cités dans le Crétacé inférieur des Taurides occidentales (d'après Bassoullet *et al.*, 1978)



REMERCIEMENTS

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PLANCHES

PLANCHE - I

Fig. 1 - *Salpingoporella diarica* Radoici, sections longitudinales et transversales obliques.

Ech. 853 K, 30 X.

Fig. 2 - *Salpingoporella dinarica* Radoicic, sections longitudinales.

Ech. 853 K. 33 X.

Fig. 3 - ? *Cylindropurella* sp., section longitudinale.

Ech. 133 A 5. environ 40 X.

Fig. 4 - ? *Cylindroporella* sp., section transversale.

Ech. 133 A 4. environ 40 X.

Fig. 5 - *Salpingoporella muehlberghii* (Lorenz), section transversale.

Ech. 133 A 4. 65 X.

Fig. 6 - *Salpingoporella istriana* (Gusic), section longitudinale.

Ech. 133 A 5. 27 X.

Fig. 7 - *Salpinguporella istriana* (Gusic), section transversale.

Ech. 133 A 5. 27 X.

Fig. 8 - ? *Cylindroporella* sp., section longitudinale tangentielle.

Ech. 133 A 8. 55 X.

Fig. 9 - *Cylindroporella* cf. *elitzae* Bakalova, section transversale.

Ech. 881 K 4. 35 X.

Fig. 10 - *Cylindroporella* cf. *elitzae* Bakalova, section transversale.

Ech. 881. K 2. 33 X.

Fig. 11 - *Cylindroporella* cf. *elitzae* Bakalova, section transversale oblique.

Ech. 881 E 5. 35 X.

M. JAFFREZO, A. POISSON et A. AKBULUT PLANCHE - I

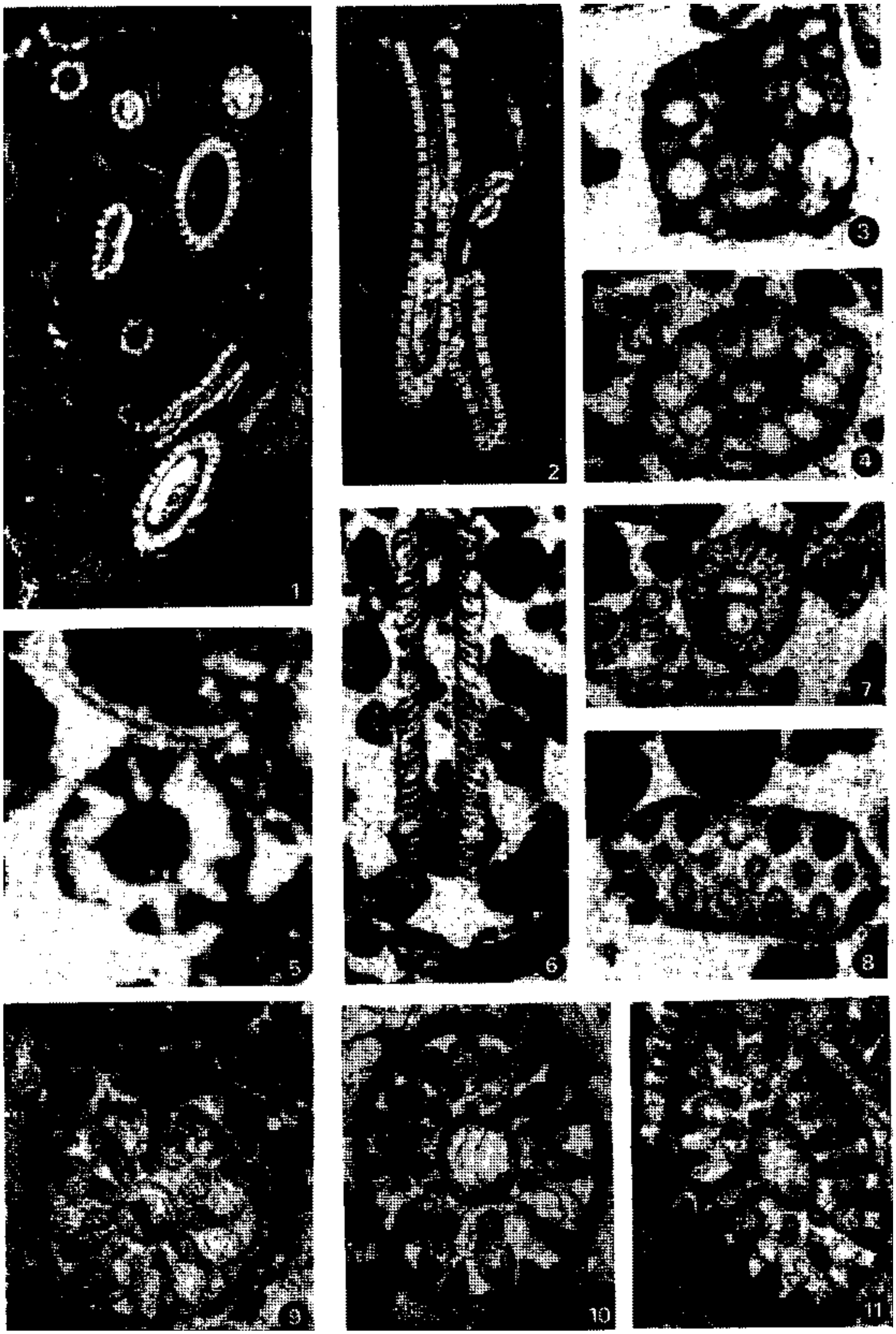

PLANCHE - II

Fig. 1 - *Pseudoepimastopora pedunculata,* n.sp., section longitudinale.

Ech. 881 E 16. 15 X.

Fig. 2 - *Pseudoepimastopora pedunculata,* n.sp., holotype section longitudinale.

Ech. 881 E 9. 15 X.

Fig. 3 - *Pseudoepimastopora pedunculata,* n.sp., section longitudinale.

Ech. 881 E 9. 15 X.

Fig. 4 - *Acroporella* cf. *radoicicae* Praturlon, section transversale oblique.

Ech. 133 A 3. 25 X.

Fig. 5 - *Acroporella cf. radoicicae* Praturlon, section transversale.

Ech. 133 A 5. 24 X.

Fig. 6 - *Pseudoepimastopora pedunculata,* n.sp., section longitudinale tangentielle.

Ech. 881 E 6. 15 X.

Fig. 7 - *Acroporella* cf. *radoicicae,* section longitudinale oblique.

Ech. 133 A 8. 20 X.

Fig. 8 - *Acroporella* cf. *radoicicae* Praturlon, section tangentielle.

Ech. 133 A 2. 30 X.

Fig. 9 - *Harlanjohnsnnella cf. annulata* Elliott, section longitudinale tres oblique.

Ech. 881 E 10. 23 X.

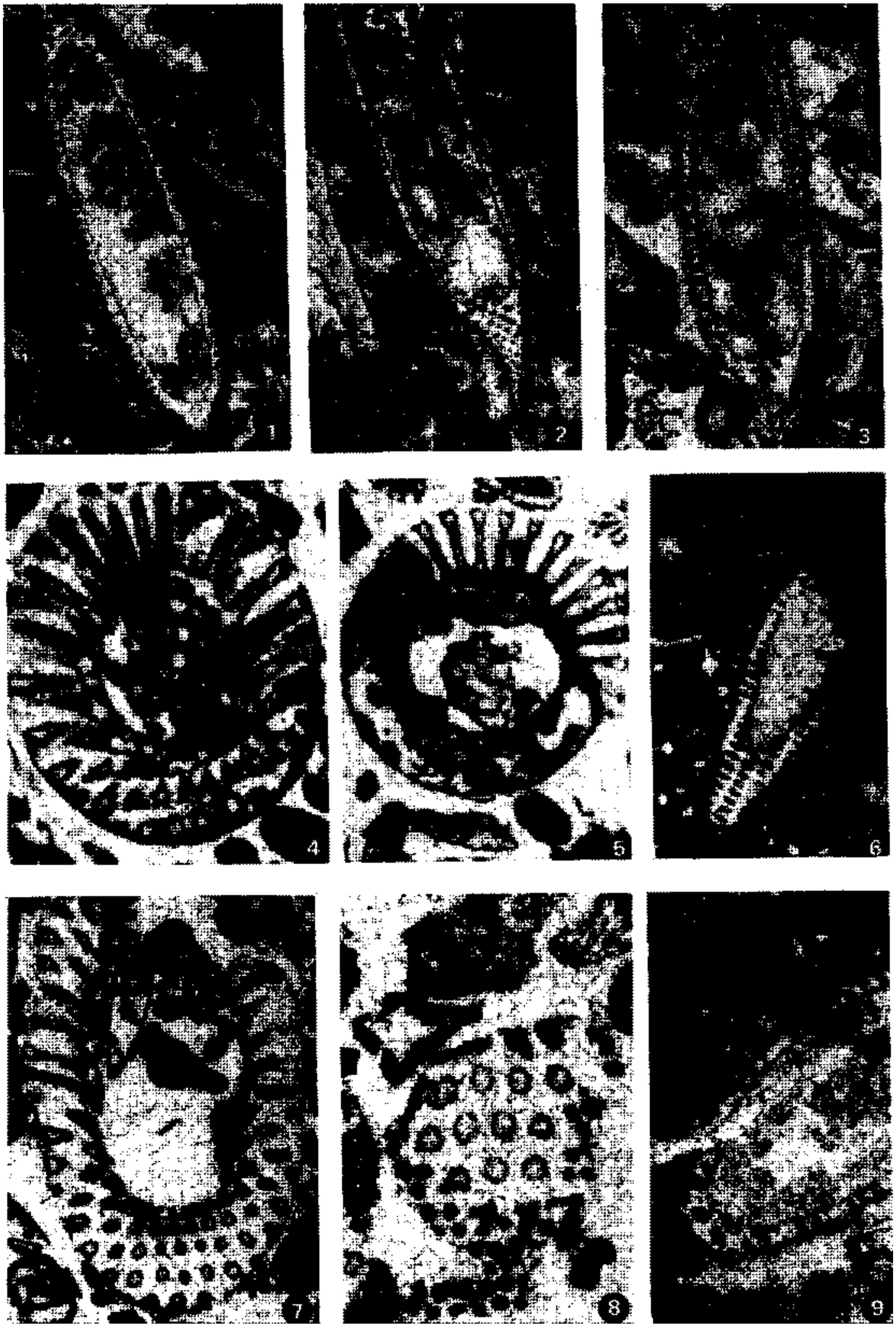
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PLANCHE - III

Fig. 1 - *Suppiluliumaella polyreme* Elliott, section transversale oblique.

Ech. 133 A 3. 30 X.

Fig. 2 - *Pseudotriploporella imecikae,* n.g., n.sp., section longitudinale parallele a l'axe.

Ech. 881 E.

Fig. 3 - *Pseudotriploporella imecikac,* n.g., n.sp., section trensversale oblique.

Ech. 881 E 8. 16 X.

N.B.: le sommet de l'algue se situe vers le has de la photographie.

Fig. 4 - *Suppiluliumaella polyreme* Elliott, section transversale.

Ech. 133 A 4. 32 *X.*

Fig. 5 - *Pseudotriploporella imecikae,* n.sp., holotype, section longitudinale parallele a 1'axe.

Ech. 881 E 4. 11 X.

Fig. 6 - *Pseudutriploporella imecikae,* n.sp., section longitudinale axiale.

Ech. 881 E 6-1. 10 X.

Fig. 7 - *Suppiluliumaella polyreme* Elliott, section transversale oblique.

Ech. 133 A 3. 28 X.

Fig. 8 - ? *Cylindroporella* sp., section longitudinale oblique.

Ech. 133 A 9. 55 X.

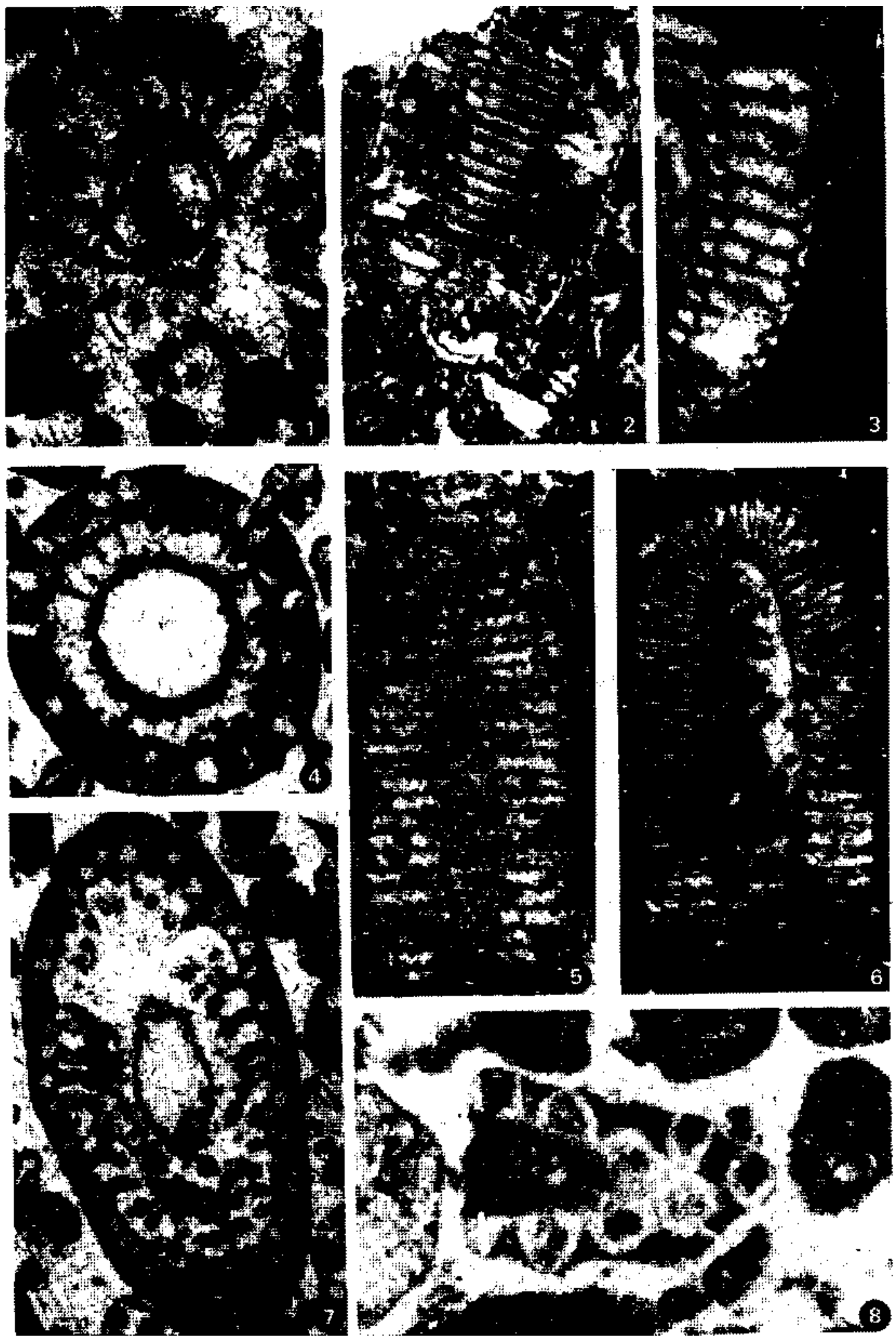
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PLANCHE - IV

Fig. 1 - ? *Suppiluliumaella polyreme* Elliott, section longitudinale.

Ech. 133 A 7. 23 X.

Fig. 2 - *Pseudoepimastopora peduncutala,* n. sp. et ? *Triploporella* sp.

Ech. 881 E 13. 10 X.

Fig. 3 - ? *Triploporella* sp., section longitudinale oblique.

Ech. 881 E 7. 12 X.

Fig. 4 - ? *Triploporella* sp., section longitudinale oblique.

Ech. 881 E 18. 10 X.

Fig. 5 - *Suppiluliumaella polyreme* Elliott, section transversale tres oblique.

Ech. 133 A 10. 17 X.

Fig. 6 - ? *Triploporella* sp., section transversale.

Ech. 881 E 19. 10 X.

Fig. 7 - Sp. A., section transversale oblique.

Ech. 133 A 10. 20 X.

Fig. 8 - *Salpingoporella melitae* Radoicic, section transversale.

Ech. 881 E 1. 27 X.

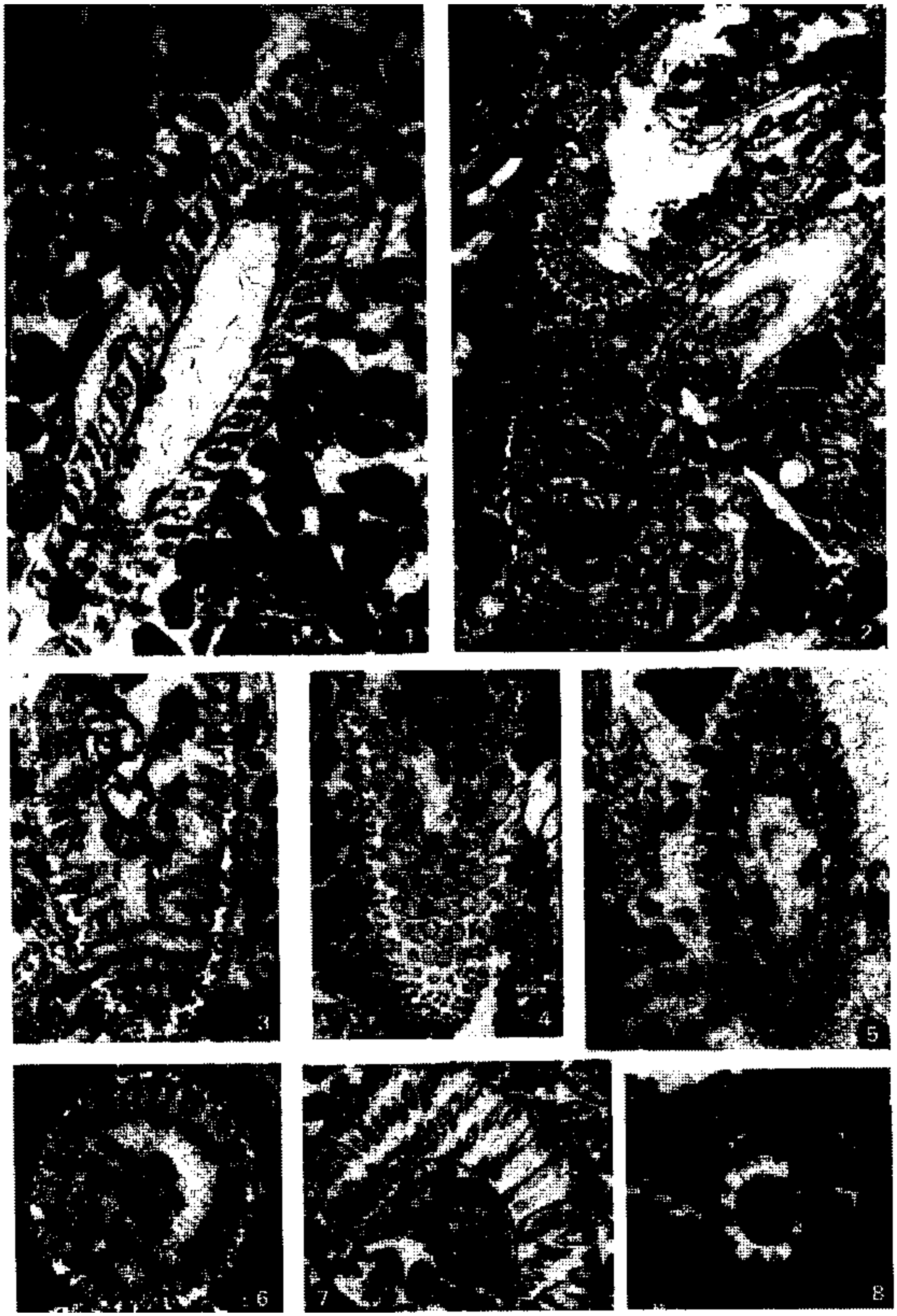

PLANCHE - V

Fig. 1 - *Triploporella cf. marsicana* Praturlon, section longitudinalc oblique.

Ech. 881 E 10. 7 X.

Fig. 2 - Sp. A., section longiludinale partielle.

Ech. 133 A 9.

Fig. 3 - ? *Triploporella* sp., section longitudinale.

Ech. 881 E 13. 12 X.

Fig. 4 - *Pseudotriploporella imecikae, n.* sp., section transversale tres oblique.

Ech. 881 E 3. 12 X.

Fig. 5 - *Suppiluliumaella* sp., section transversale.

Ech. 133 A 6. 12 X.

Fig. 6 - *Tripluporella* sp., section tangentielle.

Ech. 881 E 7. 25 X.

Fig. 7 - ? *Triploporella* sp., section transversale.

Ech. 881 E 2. 15 X.

Fig. 8 - *Cylindroporella* sp. et *Salpingoporella dinarica* Radoicic, sections transversales.

Ech. 133 A 5. 60 X.

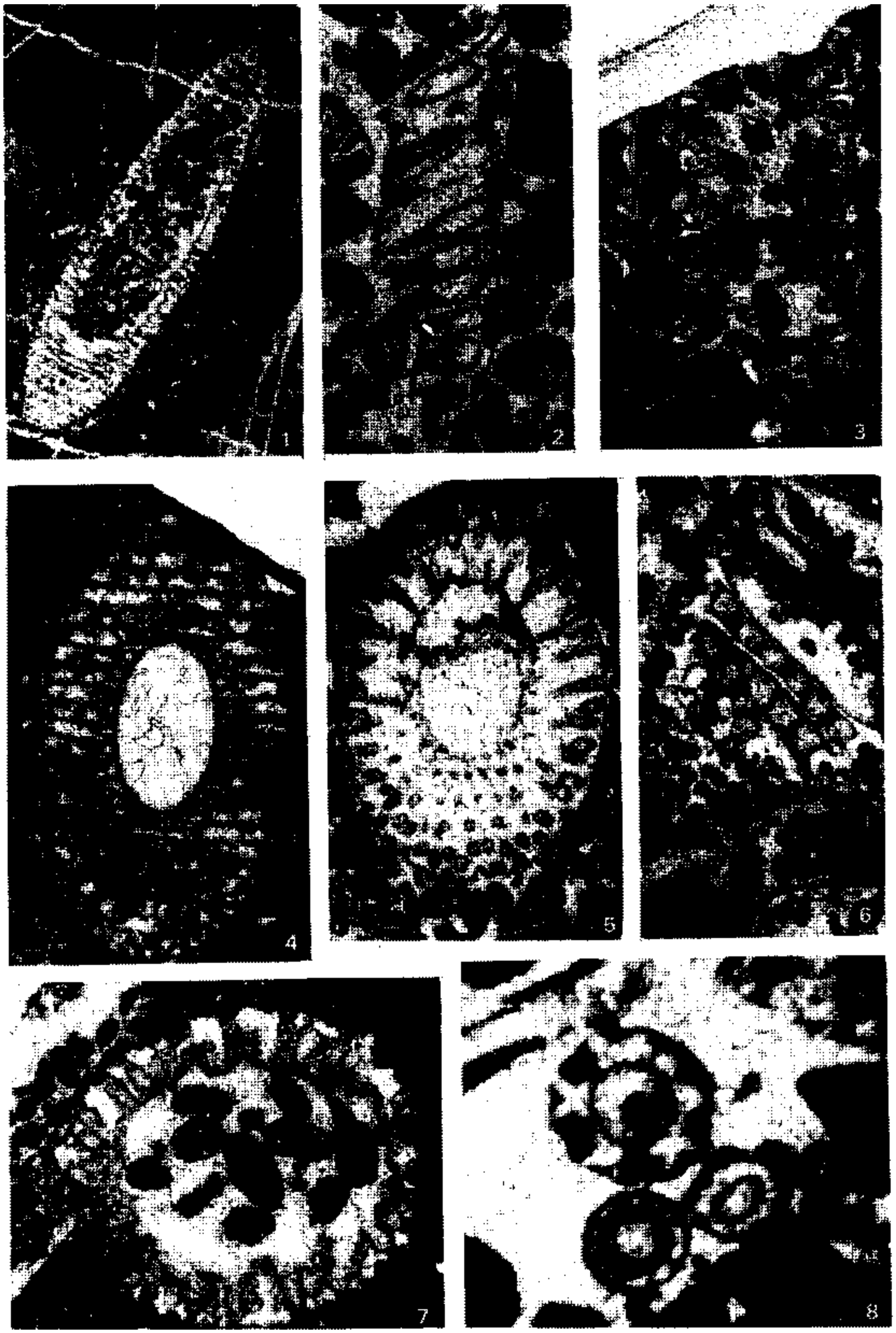
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PLANCHE - VI

Fig. 1 - Microfacies du Cretace inferieur des Bey Dağları.
Structure oeillee (bird eye) dans un sahlc a pellets. La fissure ouverte a gauche est prohablement une fente dc dessication. Noter le sediment geopete qui remplit les cavites en partie. Ech. 15 X.

Fig. 2 - Microfacics du Cretace inferieur des Bey Dağları.
Structure oeillce et fentes de dessication horizontales dans un sahle fin a pellets. Les zones les plus sombres (formant des horizons plus compacts en has et en haut), correspondent prohahlement a la trace d'anciens voiles algaircs de type stromatolitique. Ech. 10 X.

Fig. 3 - Pseudoepimastopora *pedunculata* n. sp., aprandissement de la photo de la Planche II. fig. 2. Remarquer la forme des ramifications et ce qui pourrait etre le reste d'un eylindre cental fossilise.

Fig. 4 - :*Triploporella* sp. agrandissement de la photographie de la Planche IV, fig. 3. Remarquer les differents types de calcification.


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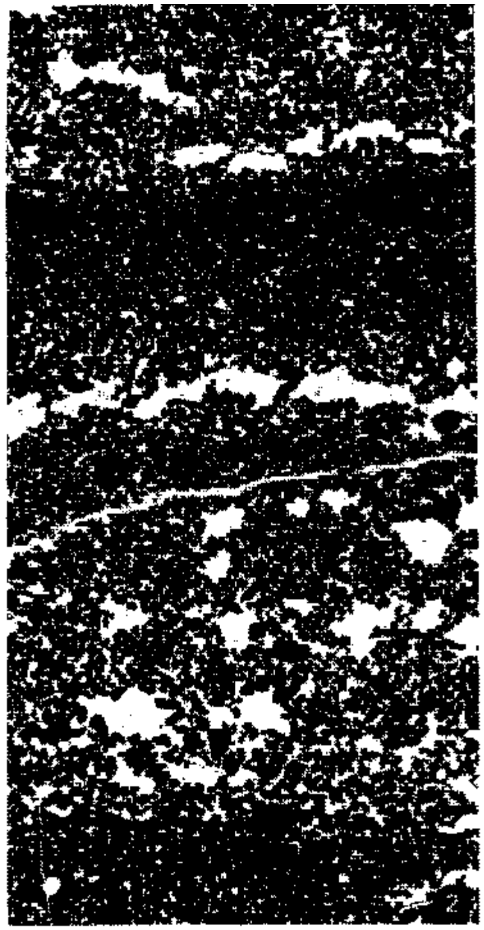
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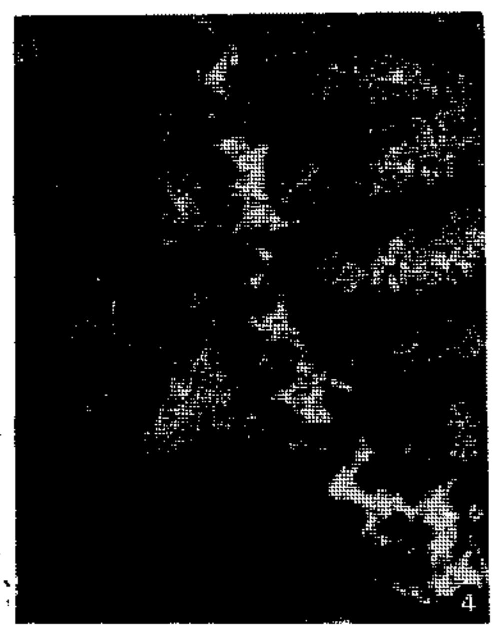
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QUANTITATIVE DETERMINATION OF MOLYBDENUM, NICKEL, VANADIUM AND TITANIUM IN THE ASPHALTITES AND ASPHALTITE ASHES BY XRF-SPECTROSCOPY

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Mineral Research and Exploration Institute of Turkey

ABSTRACT. — The quantitative determinations of Mo, Ni, V and Ti in the asphaltite occurrences of Southeastern Turkey and in their ashes as well have been made by XRF spectroscopy. The matrix effects in the analyses of these elements have been minimised by employing Nb, Co, Ce and La as internal standards, corresponding to Mo, Ni, V and Ti respectively.

1. INTRODUCTION AND BACKGROUND INFORMATION

Recovery of valuable minerals, i.e.Mo, V, Ni, and Ti contained in the asphaltites and their ashes and synthetic gas, liquid and solid fuels as well by pyrolysis have been investigated by the M.T.A. Institute with a purpose to evaluate the asphaltite occurrences of Southeastern Turkey (1). XRF (X-ray fluorescence) spectroscopy is employed for qualitative analyses, to minimise the amount of samples used and to reduce the testing period.

The method employed in the matrix corrections and in the selection of internal standards taken into consideration in the present study is described in reference (2).

2. APPLICATION

During XRF analyses, GE - SPG - 5 vacuum spectrometer arid GE - SPG - 9 gas spectrometer, in which a mixture of 10 % methane and 90 % argon is streamed, are used.

2. 1. Mo, Ni, V and Ti determinations in asphaltites and their ashes

During these studies Nb, Co, Ce and La arc used as internal standards, corresponding to Mo, Ni, V and Ti, respectively, as these minerals have similar wavelengths (3) (Fig. 1). Optical spectrographic studies have, on the other hand, shown that the elements referred above and taken as internal standards in these studies, are not present in the samples.

Table 1 shows the elements determined and the curves obtained for the respective internal standards. No elements, however, emitting characteristic x-rays having necessary intensity to affect the method employed could be identified between or around the curves (4).

Table - 1

Element to be determined			*Internal standard used*		
V	Peak $2\theta_K$	= 122°.80	Ce	Peak $2\theta_K$	= 127°.85
	B.G. 2θ	= 124°.56		B.G. 2θ	= 132°.00
Ni	Peak $2\theta_K$	= 70°.80	Co	Peak $2\theta_K$	= 69°.00
	B.G. 2θ	= 73°.00		B.G. 2θ	= 67°.80
Mo	Peak $2\theta_K$	= 28°.40	Nb	Peak $2\theta_K$	= 29°.90
	B.G. 2θ	= 27°.40		B.G. 2θ	= 30°.90
Ti	Peak $2\theta_K$	= 85°.70	La	Peak $2\theta_L$	= 82°.50
	B.G. 2θ	= 89°.00		B.G. 2θ	= 81°.00

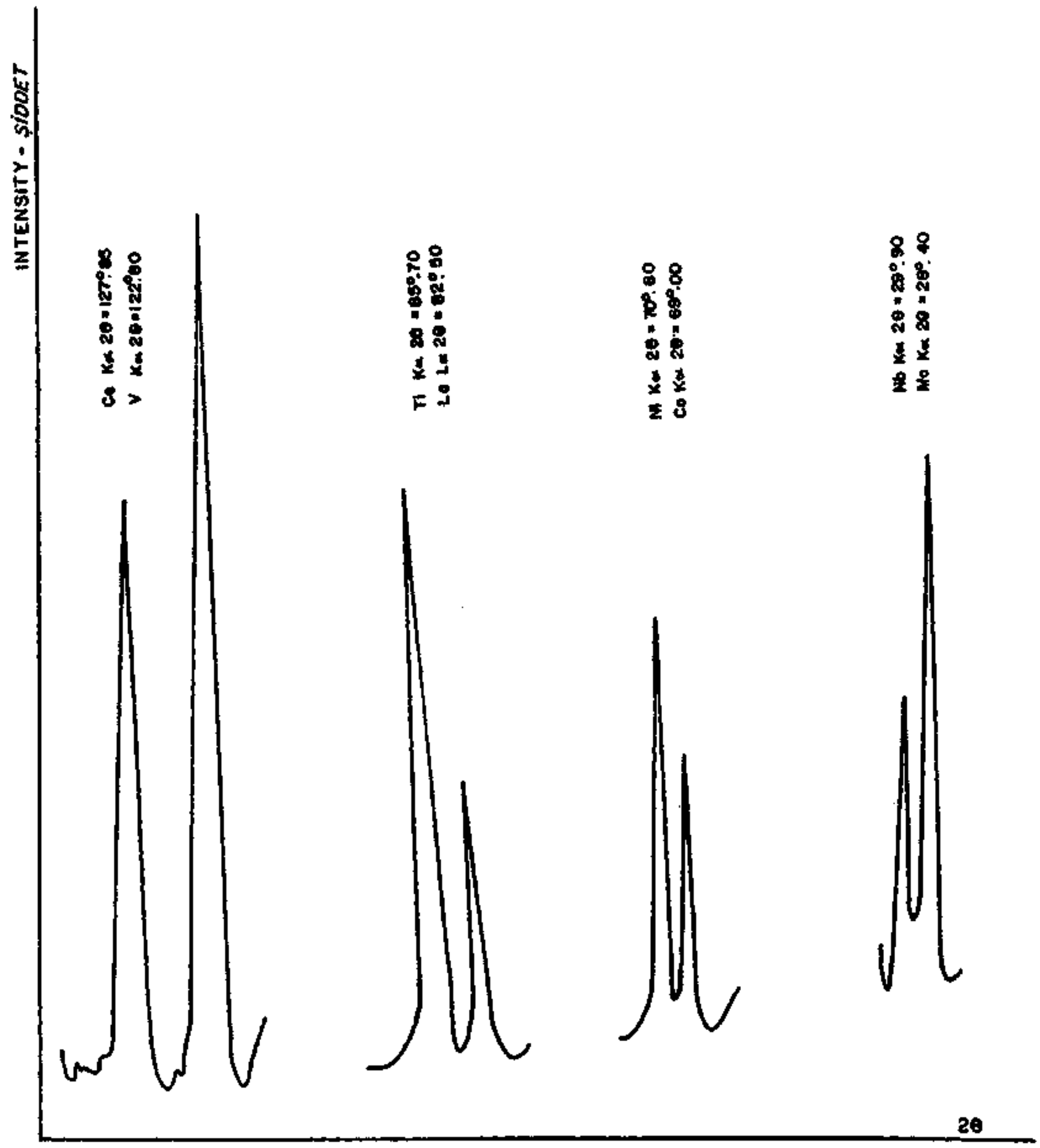

Fig. - 1

2.2. Preparation of standard sample tablets

a. Mo, Ni and V standards. — Mo, Ni and V standard solutions and Nb, Co and Ce internal standards, of variable concentrations are added to 250 mg $Li_2B_4O_7.5H2O$+250 mg $SiO2$+ 500 mg cellulose mixture. The mixture thus obtained is ground homogeneously after drying at 80°C for one night and sample tablets are made using 25-ton presses.

b. Ti standards. — Ti standards are prepared similarly, with the exception of adding La in solution as an internal standard.

c. Preparation of samples. — During the preparation of samples, the method employed is similar and internal standards arc added to a mixture of 250 mg $Li_2B_4O_7.5H_2O$+250 mg sample and 500 mg cellulose by drops.

2.3. Measuring conditions

	Mo	*Ni*	*V*	*Ti*
Crystal (A°)	**Fibre (2.8)**	**Fiber (2.8)**	**Fiber (2.8)**	**Fiber (2.8)**
Anticathod	**W**	**W**	**Cr**	**W**
Flow intensity of tube (mA)	**40**	**40**	**40**	**40**
Tube voltage (kV)	**50**	**50**	**50**	**50**
Interval (inch)	**0.005**	**0.005**	**0.005**	**0.005**
Pressure	**Vacuum**	**Vacuum**	**Vacuum**	**Vacuum**
Counter voltage (V)	**1250**	**1330**	**1370**	**1300**
Discrimination limit (V)	**20-60**	**30-50**	**30-60**	**10-40**
Counting time (sec.)	**20**	**20**	**20**	**20**

3. EVALUATION OF RESULTS

Results are evaluated on the basis of the following equation (2) and seperate curves are obtained for each element (Fig. 2).

$$\frac{I - Io}{Is - Ios} = KC$$

Where;

I is the intensity of the secondary x-rays emitted by the sample at the measured wavelength;

lo natural background around the measured wavelength;

Is intensity of the x-rays emitted by the internal standard at the measured wavelength;

los natural background of the internal standard;

K Constant

C Concentration of the element to be analysed in the sample.

Table 2 shows the Mo, Ni, V and Ti percentages of the asphaltite, asphaltitc ash, resulting carbonaceous residue and ash as well, determined by the method described above.

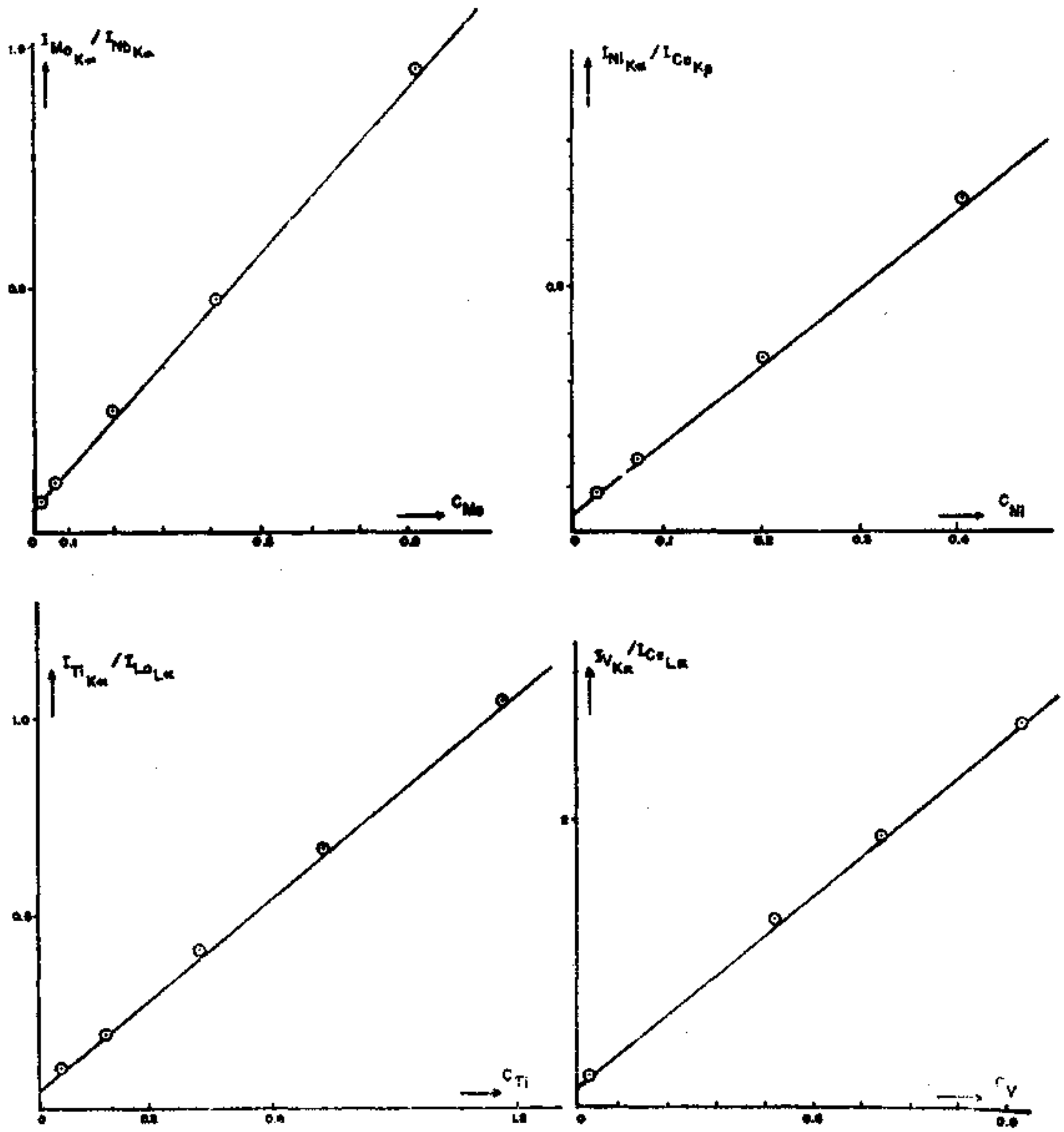

Fig. - 2

Table - 2

Element	*Asphaltite* (%)	*Asphaltite ash* (%)	*Pyrolysis coke* (%)	*Pyrolysis coke ash* (%)
Mo	0.13	0.29	0.18	0.31
Ni	0.15	0.33	0.18	0.35
V	0.15	0.35	0.18	0.35
Ti	0.14	0.33	0.13	0.33

Absolute error : ± 0.01

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Translated by: E. Filiz Dikmen

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KESME KUVVETLERİ İLE MODELLERİN DEFORMASYONLARINDA ETKEN FAKTÖRLERİN ROLÜ

Erkan TANYOLU

Devlet Mühendislik ve Mimarlık Akademisi, Zonguldak

ÖZET. — Tektonik olayların ve bunların tabiatta kalan izleri olan tektonik yapının jeolojide çok önemli olması ve arazi çalışmalarının bu olaylara yeterli açıklığı getirememesi, bu problemlerin çözümü için laboratuvar deneylerini zorunlu kılmaktadır. Bu çalışmada, tabiatta çok sık rastlanan kesme kuvvetleri ile oluşan deformasyonlara etkiyen faktörler incelenmiş, bunların deformasyon esnasındaki rolleri araştırılmıştır. Akıcı ve kırıklı deformasyonlar ayrı ayrı ele alınmış, su oranı, kalınlık (yükseklik) ve zaman (deformasyon hızı) gibi değişkenlerin deformasyonu nasıl ve ne kadar etkiledikleri saptanmıştır.

I. GİRİŞ

Tektonik olayların, bu olaylar sonunda meydana gelen yapının jeolojide büyük önem taşıdığı tartışılmaz bir gerçektir. Tektonik olaylarla ilgili, henüz çözümlenmemiş bir çok sorun var olduğu gibi, yerkabuğunda görülebilen tektonik yapı izleri de bu olaylara fazla bir açıklık getirememektedir. Tektonik olayların akışı, oluşan deformasyon evrelerinin ancak bir kısmı nadiren görülebilmektedir. Bu olaylar ya depremlerde olduğu gibi çok kısa bir zaman içinde ansızın meydana gelirler, izlemek için ne gerekli hazırlık, ne de yeterli zaman vardır, ya da olaylar o kadar yavaş olurlar ki, sezmek olanaksızdır.

Tektonik olaylar tümüyle izlenemediğinden, bunları oluşturan kuvvetlerin yönü, şiddeti, süresi gibi tektonik yapıyı etkiyen diğer koşulları ölçmek, ya da saptamak çok defa olanaksızdır.

Tektonik olaylarla yerkabuğunda oluşan çatlak, kırık gibi izler, deformasyonların ancak son safhalarına aittirler. Aynı tektonik yapının, değişik türdeki deformasyonlarla oluşabileceği veya aynı bölgede birden fazla tektonik olayın meydana gelebileceği düşünülürse, doğadaki tektonik izlerin değerlendirilmesi çok daha zorlaşır. Bu olayları açıklayabilmek, bu sorunları çözümleyebilmek için bir olanak da, laboratuvar deneyleridir. Doğadaki olaylar, benzer koşullar altında ve aynı şekilde laboratuvarda yapılabilirse, kısmen de olsa, konuya açıklık getirilebilir. Bunun için kuşkusuz yüzlerce deney yapmak gerekecektir, önce deformasyona etkiyen faktörler saptanacak ve bunlardan yalnız biri, belli bir yöntemle değiştirilerek diğerleri sabit tutulacaktır. Bu faktörün etkisi saptandıktan sonra, sırasıyle diğer faktörler de teker teker değiştirilerek incelenecektir.

Doğada rastlanan deformasyonların büyük bir kısmı kesme kuvvetleri altında oluşurlar. Arazi çalışmaları sırasında sık sık karşılaşılan bu deformasyon türü hakkında bildiklerimiz çok az olduğundan, çalışma konusu olarak kesme veya makaslama kuvvetleriyle oluşan deformasyonlar seçilmiştir. Bu deformasyon türü hakkında aşağıda gerekli teorik açıklamalar ayrıca yapılacaktır.

Modellerin yapımı için yapay ve doğal birçok madde, çeşitli karışımlarda denenmiş, fakat alınan sonuçlar değerlendirildiğinde, yerkabuğunun niteliklerine en yakın sonuçları veren maddenin kil olduğu saptanmıştır. Kilin değişik türlerinin incelenmesi sonunda da, deformasyonu en iyi biçimde kaolin-O ile izlemek mümkün olduğundan ve en belirgin tektonik yapı bu malzeme ile sağlandığından, modellerin yapımında kaolin-O kullanılmıştır (Tablo 1).

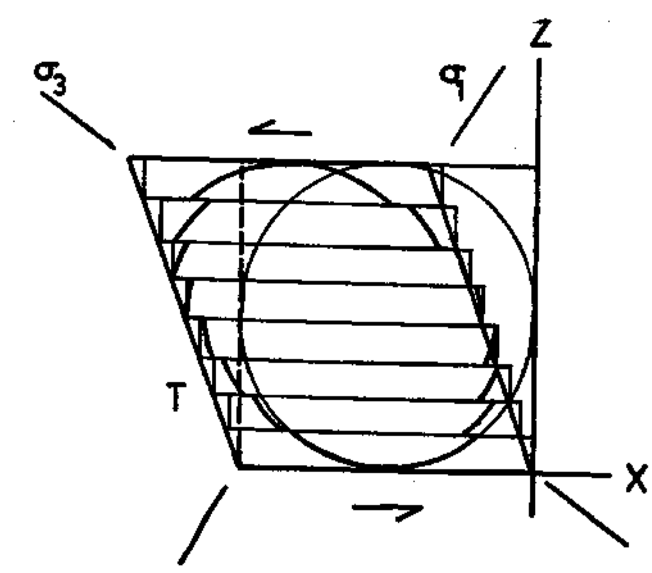
Tablo 1 - Kaolin-O nun kimyasal ve mineralojik bileşimi (% ağırlık)

Kimyasal bileşim (%)		*Mineralojik bileşim (%)*	
Si_2O	59.9	Mika	46
Al_2O_3	27.0	Kuvars	30
TiO_2	1.3	Kaolinit	24
Fe_2O_3	1.0		
CaO	0.2		
MgO	0.4		
K_2O	4.1		
Na_2O	0.3		
Kül	5.8		

Hubbert'in (1937) «boyut analizi» hesaplarına göre, modelin boyutları ile birlikte, deformasyona etkiyen diğer faktörler de (zaman, sağlamlık vb.) 10^{-5} ölçeği ile büyütülürse, yapılan deneylerle doğadaki deformasyonlar arasındaki benzerlik daha iyi görülmektedir. Değişik su oranlarıyle yapılan deneylerde, bu faktörün de deformasyona etkisinin inceleneceği göz önünde tutularak, esas deneyler için en uygun su oranının (ağırlıkça) % 36 olduğu yapılan araştırmalar sonunda ortaya çıkmıştır.

2. KESME (MAKASLAMA) KUVVETLERİ İLE DEFORMASYON

Bu deformasyon türünde, yani kesme kuvvetleri altında, homojen ve izotrop bir küreden üç eksenli bir elipsoit oluşur. Konuyu basitleştirmek için, elipsoitin ortanca ekseninin uzunluğunun değişmediği, yani başlangıçtaki kürenin yarıçapına eşit olduğu özel durumu alırsak, en büyük ve en küçük eksenlerin (c ve a) bulunduğu düzlemde, deformasyonun her evresinde kürenin en büyük dairesinin alanına eşit bir elips meydana gelecektir (Şek. 1). Yani $c>b>a$ ve $x//a$, $b//y$, $c//z$ ise, deformasyonun her evresinde $a.c=r^2=$ sabit olur. Burada x,y,z dik eksenli koordinat sistemi, a,b,c elipsoitin eksenleri ve r de kürenin yarıçapıdır.

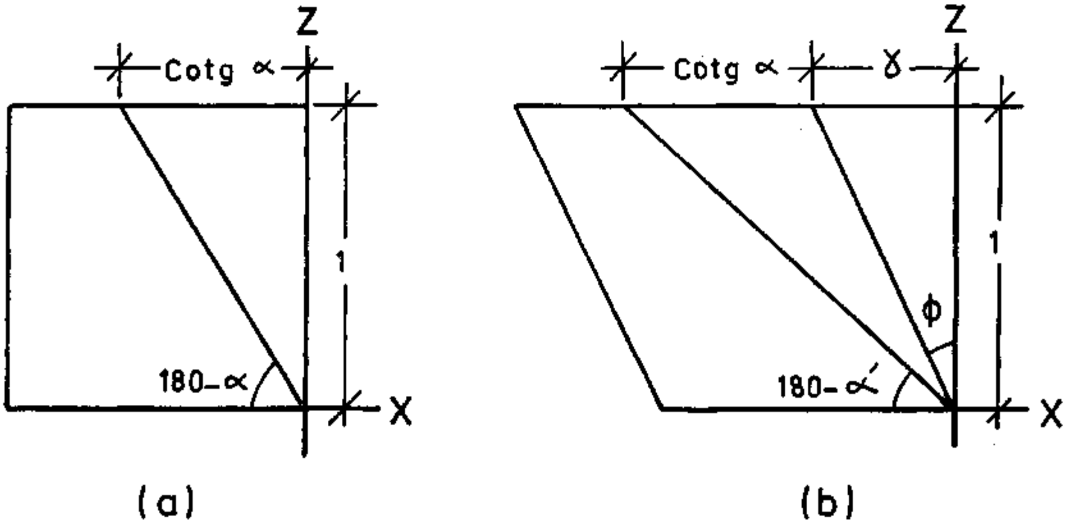


Şek. 1 - Monoklinal deformasyondaki gerilme kuvvetlerinin durumu ve deformasyon düzlemindeki dairenin elipse dönüşümü.

Kesme kuvvetleri altındaki deformasyonlarda kuvvetler, monoklinal simetrili olduklarından Hoeppener'e (1969) atfen bu deformasyonlara «monoklinal deformasyon» lar diyoruz. Şu halde ileride bu terim, kesme kuvvetleri altında oluşan deformasyonlar için kullanılacaktır. Monoklinal deformasyonlarda yalnız bir maksimum kesme düzlemi vardır (Şek. 1 de T) ve düzlem xy düzlemine paralel, z eksenine diktir. Bu tür deformasyonlarda, kesme kuvvetleri ile aynı yönde ve xz düzleminde bir iç rotasyon oluşur ve bu dönmenin miktarı maksimum kesme düzlemi ile yapılan açıyla doğru orantılıdır. İç rotasyonun değeri Nadai'in (1959) aşağıdaki formülü ile hesaplanabilir (Şek. 2):

Cota' = Cot a - 8

Burada a, iç rotasyonu hesaplanacak doğrultunun deformasyondan önce ve a' aynı doğrultunun deformasyondan sonra x ekseni ile yaptığı açıdır, ö ise, aynı zamanda deformasyonun büyüklüğünü tanımlamaya yarar ve başlangıçta yz düzlemine paralel bir düzlemin iç rotasyonunun tanjantıdır (Şek. 2). 5 nın bir saniyedeki büyüklüğü *y* ile gösterilmekte ve hız ifadesi olarak kullanılmaktadır.



Şek. 2 - Monoklinal deformasyon sırasında oluşan iç rotasyonu gösteren şema.

3. MODELLERİN HAZIRLANMASI VE DEĞERLENDİRİLMESİ

Deneyler, Hoeppener'in (1969) geliştirdiği Bochum deformasyon masasında yapılmıştır. Bu masanın ortasında 50x50 cm büyüklüğünde, model yapımı için ayrılan kısmın tabanı ince ve gayet esnek bir lastikle kaplıdır. Kenarları, yapılacak olan modelin yüksekliğine göre, aynı malzeme ile kaplamaya elverişlidir. Mümkün olduğu kadar homojen hazırlanan kaolin-su karışımı, deformasyon masasındaki lastikle kaplı özel yere yeteri kadar taşınır ve istenilen yükseklik elde edildikten sonra, üst yüzü pürüzsüz bir duruma gelinceye kadar bir cetvelle düzeltilir. Bu yüzeye, siyah bir silikat tozu, özel bir aletle serpilerek, kareleri 1 cm olan bir ağ elde edilir. Bu ağın karelerinin tanımladıkları 1 cm çaplı dairelerle akıcı deformasyon izlenecektir. Şöyleki, deformasyonla paralelkenara dönüşen karelerin tanımladıkları daireler de elips olacaktır. Bu elipslerin küçük eksenlerinin büyüğüne oranları (q=a/c) ile akıcı deformasyonun değişimi ve büyüklüğü, büyük eksen doğrultusu (a_r) ile de akıcı deformasyonunyönüincelenecektir.

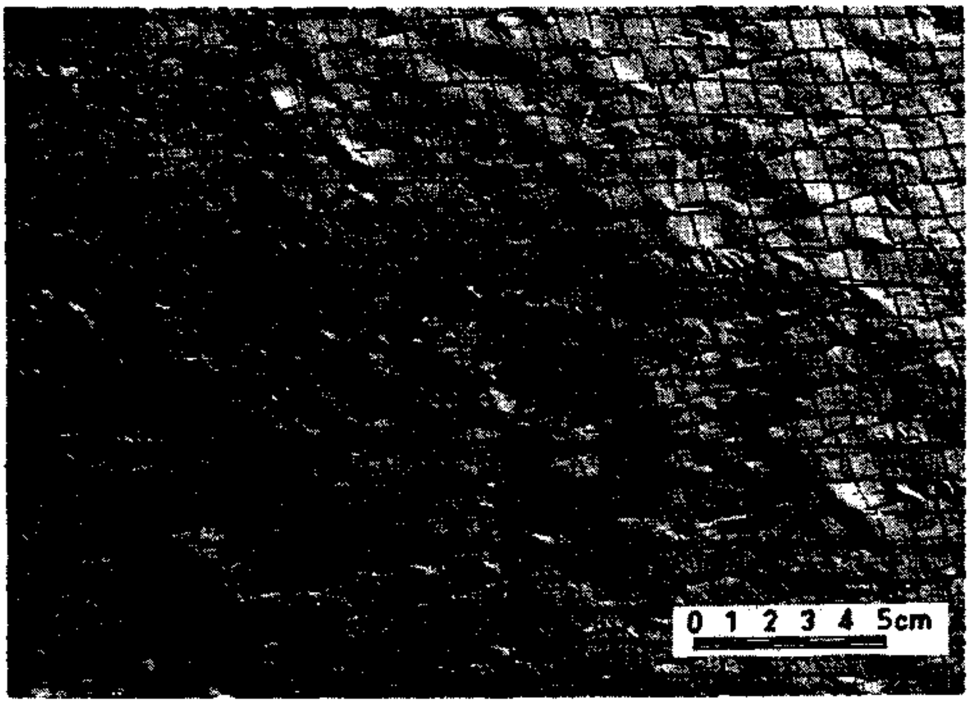
Kırıklı deformasyonun, akıcı deformasyona etkisini saptamak ve teorik hesaplarla karşılaş tırarak deneyin doğruluk derecesini denetlemek için, toplam deformasyonun (akıcı ve kırıklı deformasyonlar) incelenmesinde model yüzünün ortasına, yine silikat tozuyle yapılan 20 cm boyutlu karenin tanımladığı dairenin deformasyonundan yararlanılmıştır. Bu büyük elipsin eksenlerinden küçüğünün büyüğüne oranı (Q=a/c) toplam deformasyonun derecesini (deformasyonun bulunduğu evreyi), büyük eksen doğrultusu da toplam deformasyonun yönünü (a_z) vermektedir. Toplam deformasyonda elde edilen değerler teorik hesaplara tümüyle uyduklarından, ileride bu değerlere Q ve a, olarak değinilecektir.

Kırıklı deformasyon, model yüzünün ortasındaki 400 cm^2 lik homojen kısımdaki kırık ve çatlakların yön ve uzunluklarının ölçülmesiyle incelenmektedir.

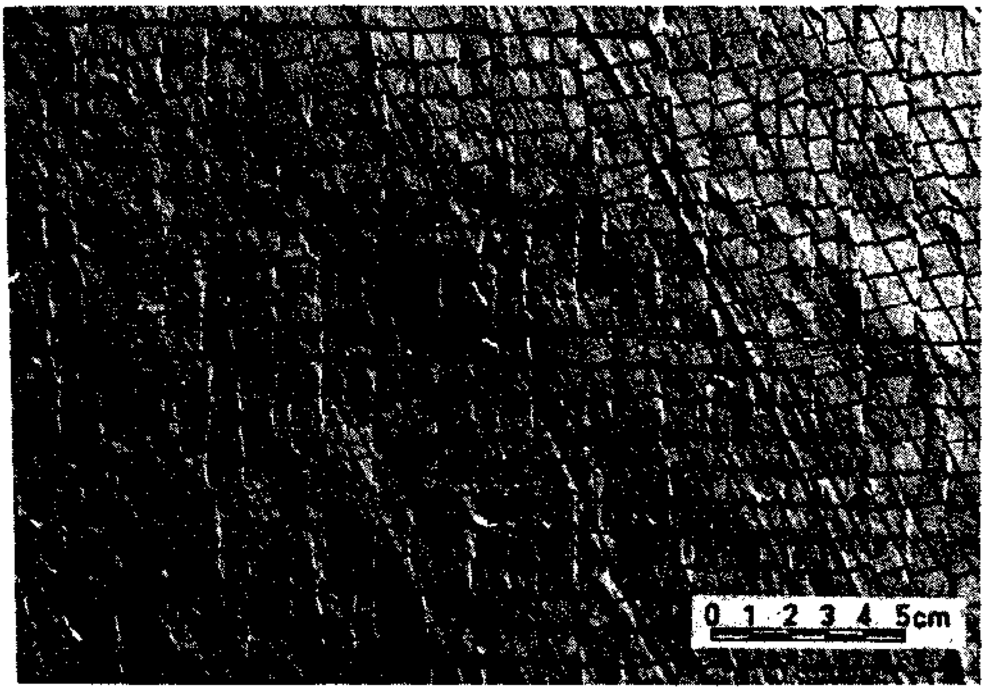
ölçmeler sırasında yapılan hatalar, boy ölçmelerinde 0.1 mm ve açılarda +_ 1° den küçük olduklarından, hata sınırları içinde kalmaktadırlar.

4. KESME KUVVETLERi İLE MODELLERİN DEFORMASYONU (MONOKLİNAL DEFORMASYON)

Homojen ve izotrop bir cismin monoklinal deformasyonunda, birbirlerine eşit iki ayrı kırık sistemi oluşur. Bunlardan biri, teorik olarak maksimum kesme doğrultusunda, diğeri de dik durumda kabul edilir. Fakat uygulamada durum biraz daha değişiktir ve kırık sistemlerinden biri maksimum kesme yüzeyi ile 18-20° lik açı yapar (Şek. 3). Bu sisteme Cloos'a (1936) atfen «sintetik sistem» (uygun sistem), diğerine yani maksimum kesme yüzeyine yaklaşık dik olana da «antitetik sistem» (aykırı sistem) denilmiştir (Şek. 4).



Şek. 3 - Monoklinal deformasyonda oluşan sintetik kırık sistemi (γ = 0.54).



Şek. 4 - Monoklinal deformasyonda oluşan anitetik kırık sistemi (γ = 0.54).

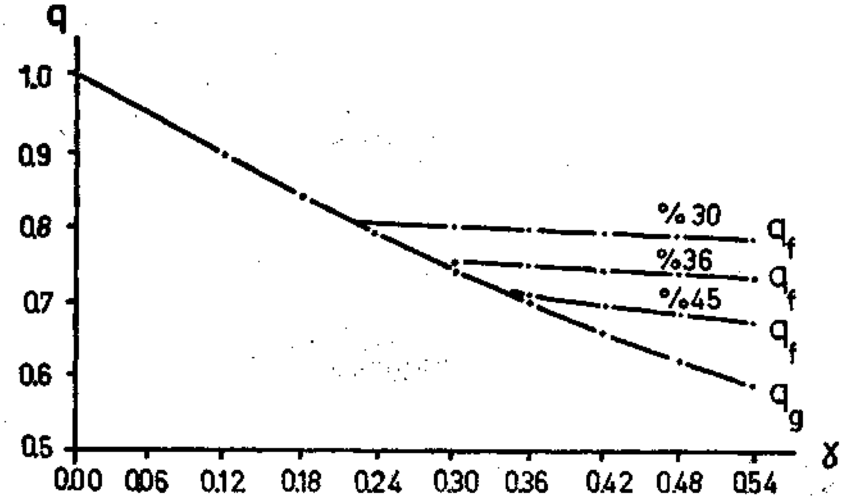
Kil modelin hazırlanması sırasında üst yüzü düzlenirken, düzlem yönüne dik bir direnç anizotropisi oluşur (Tanyolu, 1974) ve bu da tektonik yapıyı etkiler.

Anizotropinin tektonik yapıya etkisi basit olarak şu şekilde açıklanabilir: Modelin üstü, kınk sistemlerinde hangisinin doğrultusunda düzlenirse, yalnız o sistem oluşmakta ve diğeri oluşmamaktadır. Doğadaki kayaçların da izotrop olmadıkları hatırlanırsa, model yapımında oluşan bu anizotropi, bize deformasyonları daha ayrıntılı inceleme olanağını verir.

Yalnız sintetik, yalnız antitetik ve her iki sistemin birlikte oluşması, maddenin anizotropisine bağlıdır. İki sistemin birlikte oluştuğu deneylerde bunlardan birinin çoğunlukta olması ve aralarındaki oran deformasyonu etkilediğinden, hatasız bir karşılaştırma yapabilmek için, deformasyona etkiyen faktörlerin rolü, sintetik ve antitetik sistemlerin yalnız oluştukları durumlarda incelenecektir.

5. SU ORANININ ETKİSİ

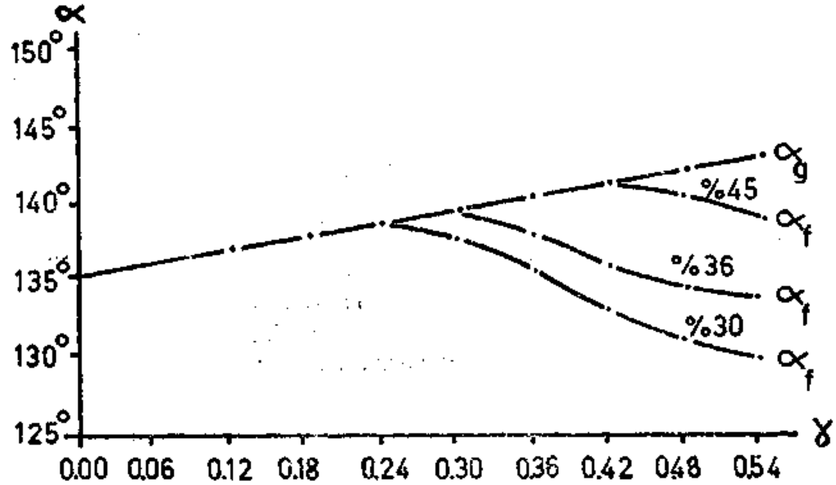
Su oranının etkisinin incelenmesi için, %30, 36, 45 su içeren kaolinden yapılan 50x50x2 cm boyutlu modeller $y = 1x1O^{-4}$ san.^{1} hızındaki kesme kuvvetleri ile deforme edilirse, önce yalnız akıcı bir deformasyon meydana gelir. Apsiste y ile deformasyon evrelerinin, ordinatta q ile deformasyon elipsleri eksenlerinin birbirlerine oranının ifade edildiği Şekil 5 te, akıcı deformasyonun değişimi görülmektedir. Akıcı deformasyonun ölçülen değerleri, teorik hesaplara tümüyle uymaktadır. % 30 su içeren modelde deformasyonun y=0.24 evresinde, %36 su içeren modelde deformasyonun y=0.30 evresinde ve %45 su içeren modelde deformasyonun y= 0.36 evresinde ilk çatlaklar oluşur. Bundan sonra kırıklı deformasyon, akıcı deformasyondan daha büyük rol oynamaya başlar ve artık deformasyon elipslerinde önemli bir basıklaşma, değişme görülmez. Çatlak ve kırıklar gelişirken, ayırdıkları bloklar, bu çatlaklar boyunca yan yana kayarlar.



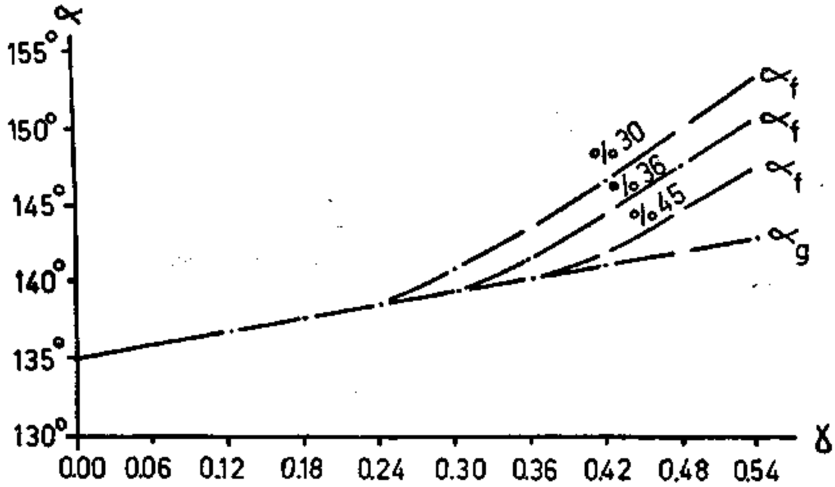
Şek. 5 - Su oranı değişik modellerin monoklinal deformasyonlarında akıcı deformasyonun γ ya bağlı değişimi.

Deformasyon elipslerinin büyük eksenlerinin yönleri incelendiğinde, yine kırıkların başlamasına kadar teorik hesaplara uygunluk görülür (Şek. 6, 7). Kırıklar oluşmaya başladıktan sonra, yalnız antitetik kırıkların oluştuğu deneylerde, gerektiğinden fazla bir sapma görülmektedir ki bu, elipslerin üzerinde bulundukları bloklarla birlikte dönmeleriyle açıklanabilir (Şek. 7). Yalnız sintetik kırıkların oluştuğu deneylerde ise, durum daha değişiktir. Şekil 6 da teorik iç rotasyonun tersine bir dönme görülmektedir. Aslında bu ters bir rotasyon olmayıp, deformasyon sırasında elipsleri tanımlayan paralelkenarların bssınç yönünde daralması, normalinde genişlemesi sonucu aldatıcı bir durum ortaya çıkmaktadır.

Sonuç olarak, modellerde su miktarı arttıkça, kırıklı deformasyon daha geç başlamakta, akıcı deformasyon sırasında ise teorik değerlerden herhangi bir sapma olmamaktadır. Gözleme dayanan bir sonuç da, su miktarı azaldıkça kırıklar belirginleşmekte, bireysel uzunlukları ve aralarındaki uzaklıklar artmaktadır. Bu, maddenin elastisitesinin artması ve daha büyük bir bölgedeki gerilimlerin boşaltılabilmesiyle açıklanabilir.



Şek. 6 - Değişik su oranlı modellerin monoklinal deformasyonlarında yalnız sintetik kırık sisteminin oluştuğu durumlarda deformasyon yönünün değişimi.

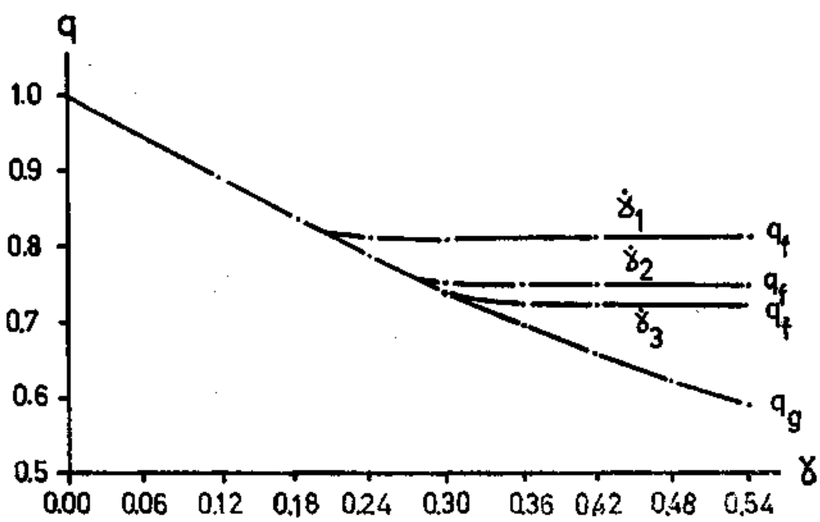


Şek. 7 - Değişik su oranlı modellerin monoklinal deformasyonlarında yalnız antitetik kırık sisteminin oluştuğu durumlarda deformasyon yönünün değişimi.

6. ZAMANIN ETKİSİ

Deformasyonun büyüklüğünü ölçmede kullanılan 8 nın birim zamandaki büyüklüğü hız olarak alınıp, *y* ile gösterilmektedir.

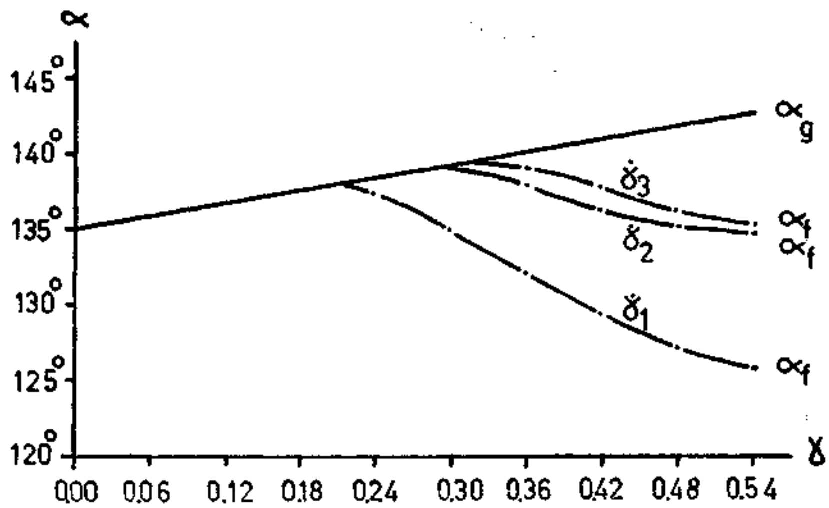
Zamanın, akıcı deformasyona ve tektonik yapıya etkisini saptamak için, aynı şekilde hazırlanmış % 36 su içeren modeller g1 hızıyle 24 saatta, y_2 hızıyle 2 saatta ve g_3 hızıyle yarım saatta deforme edilmektedirler. İlkin tüm deneylerde, teorik hesaplara uygun bir akıcı deformasyon meydana gelir (Şek. 8). Küçük hızla yapılan deneyde, deformasyonun $y = 0.21$ evresinde, orta hızla yapılan deneyde deformasyonun y = 0.30 evresinde ve büyük hızla yapılan deneyde deformasyonun g = 0.32 evresinde ili çatlaklar meydana gelirler (Şek. 8). Bundan sonra teorik değerlerle ölçülen değerler arasında farklılaşma başlar ve deformasyon ilerledikçe bu fark büyür. Deney sonunda Şekil 8 de görüldüğü gibi, teorik değerlerle ölçülen değerler arasındaki fark, deformasyon hızıyle ters, yani zamanla doğru orantılıdır.



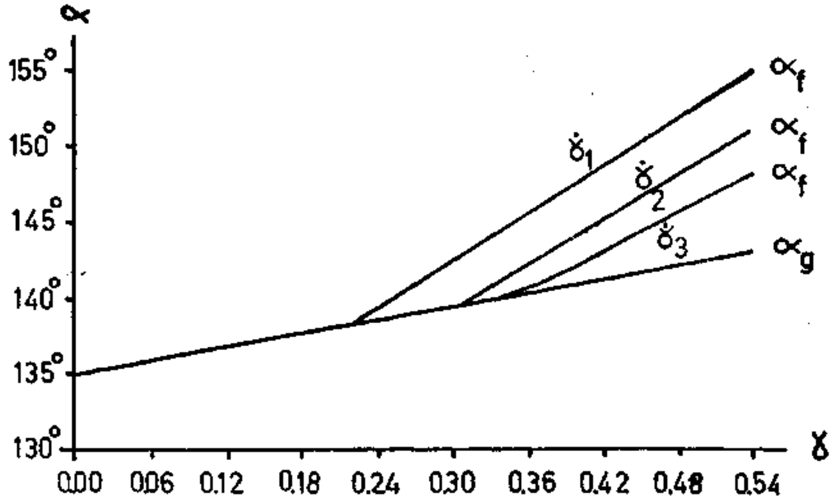
Şek. 8 - Değişik hızla deforme edilen modellerde q nun γ ya bağlı değişimi.

Yalnız sintetik veya antitetik kırık sistemlerinin oluştuğu deneylerde çatlakların oluşumundan sonra akıcı deformasyonun yönünde meydana gelen sapma (Şek. 9,10), bundan önceki bölümdekinin benzeridir ve aynı şekilde açıklanacaktır.

Akıcı deformasyon derecesinin, daha doğrusu kırıklı deformasyonun başladığı evrenin deformasyon hızıyle doğru, zamanla ters orantılı olması tiksotropi ile açıklanabilir. Hızlı deformasyonla maddenin bünyesinde meydana gelen bozulma sırasında tutulmuş suyun bir kısmı serbest kalır. Böylece viskozite düşer. Partiküller arasındaki bağlayıcı kuvvetler azalır ve partiküllerin yan yana kaymasıyle akıcı deformasyon sürer. Akıcı deformasyonun süreci, oluşan tektonik yapıya bağlı değildir.



Şek. 9 - Değişik hızla deforme edilen modellerde yalnız sintetik kırık sisteminin oluştuğu halde akıcı deformasyon yönünün γ ya bağlı değişimi.



Şek. 10 - Değişik hızla deforme edilen modellerde yalnız antitetik kırıkların oluştuğu durumda akıcı deformasyon yönünün γ ya bağlı değişimi.

7. YÜKSEKLİĞİN ETKİSİ (KALINLIĞIN ETKİSİ)

Bu etkenin incelenmesi için 2, 3.5 ve 5 cm kalınlıkta hazırlanmış benzer modeller aynı koşullar altında deforme edilir. Her iki kırık sisteminin yalnız ve ayrı oluştukları deneylerin değerlendirilmesinde önemli bir fark saptanamadı. Küçük farklar özetlenirse:

1. Akıcı deformasyonun hızı ve süreci modelin yüksekliği ile çok az miktarda azalmaktadır;

2. Modellerin yükseklikleri arttıkça, kırıklar arasındaki mesafe artmakta ve dolayısıyle kırıkların toplam uzunlukları biraz azalmaktadır;

3. Gözleme dayanan bir fark da, modellerde kırıklar, düzgünlüklerini yükseklikle kaybetmekte ve aralarındaki açıklıklar artmaktadır.

8. SONUÇ

Kesme kuvvetleri altında oluşan, yani monoklinal simetrili deformasyonlarda, tektonik yapıya etkiyen faktörlerden su miktarı, zaman ve kalınlığın rolü ayrı ayrı incelenmiştir. Sonuçlan özetlemek için deneyleri q_f in değişimine göre iki ayrı bölümde inceleyelim: Birinci evre, çatlak ve kırıkların belirgin oluşumuna kadar olan deformasyon, ikinci evre ise, deneyin bundan sonraki kısmı, yani kırıklı ve kısmen akıcı.

Deneylerin tümünde birinci evrede yalnız akıcı deformasyon oluşmaktadır. Tektonik yapıya etkiyen yukarıdaki faktörlerden hiç birinin bu evrede etkisi olmamakta ve oluşan akıcı deformasyon, toplam deformasyona, daha doğrusu teorik hesaplara tümüyle uymaktadır. qf değeri, deformasyonun bu evresinde bütün deneylerde yaklaşık olarak doğrusal ve aşağıdaki formüle göre değişmektedir:

$$q_f = 1 - 0.8g$$

Akıcı deformasyonun maksimum büyüklüğü, yani kırıkların oluşumuna kadar olan deformasyon evresi, malzemenin su miktarına ve deformasyon hızına bağlıdır. Su miktarının artması ve deformasyon hızının yükselmesiyle kırıkların oluşum evreleri gecikmektedir.

Deformasyon kuvvetleriyle oluşan gerilimler, malzemenin mukavemeti aşıldıktan sonra oluşan çatlak ve kırıklarla boşalır. Bundan sonra sintetik kırıklar arasında kalan blokların yan yana kayması, antitetik kırıklar arasındaki blokların iç rotasyonla dönmeleriyle model deforme olmakta, yani biçim değiştirmektedir. Her iki kırık sisteminin beraberce oluştukları deformasyonlarda, sintetik ve antitetik kırıklar arasındaki bloklar, deformasyonun devamında kırıklar boyunca farklı yönlerde kayma ve dönme yapmak istediklerinden birbirlerini engellerler. Bloklar, deformasyonun gerektirdiği hareketi tamamen yapamadıkları için, bir miktar şekil değişimine uğrarlar. Bu da, kırıkların oluşumundan sonra zayıf bir akıcı deformasyonun devam etmesi demektir.

Yalnız sintetik kırıkların oluştuğu hallerde, bloklar aynı doğrultuda olduklarından birbirlerini engellemeyecekler ve hareketi yalnız sürtünme kuvveti yavaşlatacağından, etkisi ve dolayısıyle akıcı deformasyonun miktarı daha az olacaktır.

Deformasyonlarda yalnız antitetik kırık sistemi oluşmaya başlayınca, kırıklar arasındaki bloklarda biçim değişimi, yani akıcı deformasyon durur ve bloklar iç rotasyona uygun olarak dönerler.

Akıcı deformasyonun yönü, deformasyon elipslerinin büyük eksenlerindeki değişiklikle incelenmişti. Çatlak ve kırık oluşumuna kadar teorik hesaplara uyan deney sonuçları, kırıklı deformasyonun başlama önceliğiyle artan sapmalar gösterir. Antitetik kırıklar arasındaki bloklarda bulunan deformasyon elipslerinde aslında akıcı deformasyon tamamen durmuş olduğundan, herhangi bir yön değişimi söz konusu değildir. Deformasyon elipsleri veya bunların eksenleri, üstünde bulundukları bloka göre yön değiştirmemekte, fakat blok iç rotasyonla dönmektedir. Sintetik kırıklar arasındaki bloklardaki deformasyon elipslerinde ters yönde görülen dönme, yukarıda da belirtildiği gibi aldatıcı bir ters iç rotasyondur.

Deformasyon elipslerini belirleyen paralelkenarların (başlangıçta 1 cm aralıkla, silis tozuyle yapılan karelerin deforme olmuş hali) doğrultularını değiştirmeksizin, üzerinde bulundukları bloklarla beraber basınç bileşeni doğrultusunda (45° altında) basıklaşması sonucu ortaya çıkmaktadır.

Deney sonuçları ile teorik değerler arasındaki bu farklar, su miktarı ve deformasyon hızıyle azalmaktadır. Değerlerdeki ayrılmalar, kırık oluşumuyle başladığından, su miktarının veya deformasyon hızının azalmasıyle akıcı deformasyonun süresi uzayacak, kırıklı deformasyonun süresi kısalacak ve teorik değerden sapma az olacaktır.

Su miktarı ve deformasyon hızının azalmasıyle kırıkların belirginlikleri ve aralarındaki mesafe artmakta, fakat kırıkların bireysel ve toplam uzunlukları azalmaktadır. Yükseklik veya başka değimle kalınlık faktörünün önemli bir etkisi yoktur.

Kilin değişik türleri ile yapılan kesme kuvvetleri ve basınç kuvvetleri altındaki deformasyonlarda da yukarıdaki sonuçlar alınmıştır. Şu halde kil çamuru gibi elasto-plastik malzemenin fiziksel özellikleri (su oranı, viskozite, kohezyon vb.) ve zaman faktörü (deformasyon hızı), ancak akıcı veya kırıklı deformasyonun süresini, yani ilk kırıkların oluşum zamanını, önemli farklar oluşturmayacak şekilde etkilemektedirler.

Sonuçlar, deformasyonda bilhassa zaman faktörünün büyük rol oynadığı inancına uymamaktadır. Her ne kadar doğada bazı olaylar çok uzun sürelerde oluşurlarsa da, deneyler 1/2 saat ile 24 saat arasında yapılmış, yani deformasyon hızı 1:48 oranında değiştirilmiştir. Tüm deney ölçüleri (boyut, direnç, zaman gibi) 10^5 ölçeğiyle küçültüldüğünden, aslında 1/2 saat 5 yıla, 24 saat da 240 yıla tekabül eder. Bu süre jeolojide çok uzun bir zaman değildir, fakat her jeolojik olay milyonlarca yıl sürmediğinden bazıları için yeterli sayılabilir.

Ayrıca deneylerde deformasyon hızı 1:48 oranı gibi geniş bir arada incelendiğinden, varılan sonuçların gerçeğe yakın olduğu ve de diğer doğal bilimlere göre çok genç sayılan tektonik araştırmalara ışık tutacağı kanısındayız.

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DISCUSSION OF SCHRÖDINGER WAVE EQUATION IN THE MAXWELL EQUATION SYSTEM

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ABSTRACT. — Light quantum is known to exist in the general structure of light which is concidered in the electromagnetic spectrum.

It appears paradoxial when lihgt is considered to propagate as waves and at the same time carry discreat quanta.

In this article Maxvell equations are treated in the context of Helmholtz theorem and it is shown that the solution of this system is the Schrödinger wave equation.

Thus a new demention to the paradoxial situation has been added.

INTRODUCTION

It is well known that the light propagates in the form of Electromagnetic wave. In this context, maxwell equations are often used in the treatment of the propagation of optical wave (Bateman, 1955).

On the other hand, the light has been the subject of quantum mechanics due to the presence of light quantum in its structure. The Importance of Schrodinger wave equation comes from the fact that it explains one aspect of the nature of light. Sommerfeld, starting with the wave - Optic differential equation derived Schrodinger wave equation (Sommerfeld, 1928).

In this article, discussion of Schrodinger wave equation in the context of the treatment of maxwell equation system in the light of Helmholtz theorem is attempted. Thus a new demension has been added to the dualty of wave - descreat mass paradox.

THEORY

Maxwell equations in the context of Helmholtz theorem

If an F vector field complies with all the general mathematical conditions, this vector field may be considered as the sum of two vectors equation (1).

$$\vec{F} = -\Delta\varphi + \Delta \times \vec{A} \qquad (1)$$

In this equation φ is obtained by the differentiation of the scalar potential function and it is an irrotational vector. *(A)* is a potential vector an it is solenoidal.

In the context of this theorem the displacement - curreint density vector $\frac{\partial \vec{D}}{\partial t}$ may be theoretically wretten in a general form as in equation (2).

$$\frac{\partial \vec{D}}{\partial t} = -\Delta\varphi + \Delta \times \vec{H} \qquad (2)$$

It is also possible to assume a medium where φ is hot zero.

If we now arrange Maxwell's equations in accordance with the above conditions and relations we get equation system (3).

$$\frac{\partial \vec{D}}{\partial t} = - \Delta \varphi + \Delta \times \vec{H} \quad \Delta \cdot \vec{D} = \rho$$

$$\frac{\partial \vec{B}}{\partial t} = - \Delta \times \vec{E} \qquad \Delta \cdot \vec{B} = 0 \quad \text{.................................... (3)}$$

(The units used here are M.K.S. system).

Here:

φ : **Scalar potential function**

$\vec{H}$: **Magnetic field intensity vector**

$\vec{B}$: **Magnetic field induction vector**

$\vec{E}$: **Electrical field intensity vector**

$\vec{D}$: **Electrical displacement vector**

ρ : **Is defined by the relation** $\Delta \cdot \vec{D} = \rho$

The differential equations of the scalar function (φ):

The solutions of equation system (3) are the differential equations of the scalar function (φ).

If we take the divergence of both sides of the first equation. In equations system (3) we get equation (4).

$$- \Delta \cdot \Delta \rho = \frac{\partial \rho}{\partial t} \quad \text{.. (4)}$$

in an explicit form this is

$$- \Delta \cdot \left(\frac{\partial \rho}{\partial x} \vec{i} + \frac{\partial \varphi}{\partial y} \vec{j} + \frac{\partial \varphi}{\partial z} \vec{k} \right) = \frac{\partial \rho}{\partial t}$$

on the other hand $\frac{\partial \rho}{\partial t}$ **is equal to:**

$$\frac{\partial \rho}{\partial t} = \frac{\partial \rho}{\partial x} \frac{\partial x}{\partial t} + \frac{\partial \rho}{\partial y} \frac{\partial y}{\partial t} + \frac{\partial \rho}{\partial z} \frac{\partial z}{\partial t}$$

Therefore equation (5) can be written

$$- \Delta \cdot \left(\frac{\partial \varphi}{\partial x} \vec{i} + \frac{\partial \varphi}{\partial y} \vec{j} + \frac{\partial \varphi}{\partial z} \vec{k} \right) = \frac{\partial \rho}{\partial x} V_x + \frac{\partial \rho}{\partial y} V_y + \frac{\partial \rho}{\partial z} V_z \quad \text{... (5)}$$

as

$$r^2 = V^2 = V_x^2 + V_y^2 + V_z^2 \quad \text{... (6)}$$

and V velocity may be assumed canstant the variation of V_x with respect to x, V_y with respect to y, and V_z with respect to z is zero.

Under these conditions equation (5) may be written as

$$-\Delta \cdot \left(\frac{\partial \varphi}{\partial x} i + \frac{\partial \varphi}{\partial y} \vec{j} + \frac{\partial \varphi}{\partial z} \vec{k} \right) = \frac{\partial}{\partial x} (\rho V_x) + \frac{\partial}{\partial y} (\rho V_y) + \frac{\partial}{\partial z} (\rho V_z)$$

we may rearrange this as follows:

$$-\Delta \left(\frac{\partial \varphi}{\partial x} \vec{i} + \frac{\partial \varphi}{\partial y} \vec{j} + \frac{\partial \varphi}{\partial z} \vec{k} \right) = \Delta \cdot (\rho V_x \vec{i} + \rho V_y \vec{j} + \rho V_z \vec{k})$$

One solution of this equation is equation (7).

$$-\left(\frac{\partial \varphi}{\partial x} \vec{i} + \frac{\partial \varphi}{\partial y} \vec{j} + \frac{\partial \varphi}{\partial z} \vec{k} \right) = \rho V_x \vec{i} + \rho V_y \vec{j} + \rho V_z \vec{k} \quad \text{..............} \quad (7)$$

multiplying both sides of equation (7) by velocity vector in scalar form we get

$$-\left(\frac{\partial \varphi}{\partial x} \frac{\partial x}{\partial t} + \frac{\partial \varphi}{\partial y} \frac{\partial y}{\partial t} + \frac{\partial \varphi}{\partial z} \frac{\partial z}{\partial t} \right) = \rho \, (V_x^2 + V_y^2 + V_z^2)$$

from this relation equation (8) may be derived.

$$-\frac{\partial \varphi}{\partial t} = \rho V^2 \quad \text{..} \quad (8)$$

from equation (4) and (8) we can derive the wave equation (9).

$$\Delta^2 \varphi = \frac{1}{V^2} \frac{\partial^2 \varphi}{\partial t^2} \quad \text{..} \quad (9)$$

On the other hand, from equation (7) and (8) Hamiltonian equation (10) may be derived

$$\left(\frac{\partial \varphi}{\partial x} \right)^2 + \left(\frac{\partial \varphi}{\partial y} \right)^2 + \left(\frac{\partial \varphi}{\partial z} \right)^2 = \frac{1}{V^2} \left(\frac{\partial \varphi}{\partial t} \right)^2 \quad \text{...} \quad (10)$$

(Bateman, 1955).

Thus, from the discussion of maxwell's equations in the context of Helmholtz theorem, the wave equation and the important equation of geometrical optics and wave mechanics namely the Hamiltonian equation were derived for the function

$$\varphi = \varphi \, (x, y, z, t)$$

Derivation of the Schrödinger wave equation from φ function

Up to this point we derived the solutions of maxwell's equations purely an theoretical basis and in the context of Helmholtz theorem.

Thus we have shown that φ potential function has a solution giving the following wave function

$$\Delta^2 \varphi = \frac{1}{V^2} \frac{\partial^2 \varphi}{\partial t^2}$$

and that this wave propagates with a phase velocity (V) it is also shown that Hamiltonian equation.

$$\left(\frac{\partial \varphi}{\partial x} \right)^2 + \left(\frac{\partial \varphi}{\partial y} \right)^2 + \left(\frac{\partial \varphi}{\partial z} \right)^2 = \frac{1}{V^2} \left(\frac{\partial \varphi}{\partial t} \right)^2$$

is also a solution of the φ function which is the principle function of physical optics and wave mechanics.

Now we will attempt to ellucedate the physical implications in the wave mechanics of our findings.

For a monochromatic light lets assume that (φ) varies in accordance with equation (11)

$$\varphi = \psi \; (x, y, z) \; e^{i\omega t} \qquad \text{.......} \qquad (11)$$

From equation (10) and (11) we can derive equation (12)

$$- \left[\frac{1}{k_o{}^2 \psi^2} \left(\left(\frac{\partial \psi}{\partial x} \right)^2 + \left(\frac{\partial \psi}{\partial y} \right)^2 + \left(\frac{\partial \psi}{\partial z} \right)^2 \right) \right] = n^2 \qquad \text{.......} \qquad (12)$$

Substituting relation (13)

$$\frac{1}{i\, k_o \psi} \quad \frac{\partial \psi}{\partial q} = \frac{\partial S}{\partial q} \qquad \text{.......} \qquad (13)$$

in the equations we get

$$\psi = A\, e^{i k_o S} \qquad \text{.......} \qquad (14)$$

$$\left(\frac{\partial S}{\partial x} \right)^2 + \left(\frac{\partial S}{\partial y} \right)^2 + \left(\frac{\partial S}{\partial z} \right)^2 = n^2 \qquad \text{.......} \qquad (15)$$

Here (S) is action function or Hamiltonian characteristic function. Difining the relation

where $k = n\, k_o$

$\frac{\omega}{V} = k$ **the wave number, (k_o) is the volue of k in vacuum (n) refrective index with respect** to vacuum.

We also know that relation (16) exists.

$$\left(\frac{\partial S}{\partial x} \right)^2 + \left(\frac{\partial S}{\partial y} \right)^2 + \left(\frac{\partial S}{\partial z} \right)^2 = 2\, m\, (E\text{-}V) \qquad \text{.......} \qquad (16)$$

(A. Sommerfeld, Wave - Mechanics, New - York 1928 p. 3)

Here *m* is the point mass, E energy constant, V potential energy. All is the function of x, y, z coordinats.

From equations (9), (11), (15) and (16) relation (17) can be derived.

$$\Delta^2 \psi + 2\, m\, (E\text{-}V)\, k_o^2\, \psi = 0 \qquad \text{.......} \qquad (17)$$

here k_o is a universal value and can take the value of

$$k_o = \frac{2\pi}{h} \qquad \text{.......} \qquad (18)$$

where h is plank's canstant (Sommerfeld, 1928, p. 5).

If we substitude (18) in (17) we get Schrödineer's wave equation for micro mechanics for single point mass. Equation (19)

$$\Delta^2 \psi + 2\, m\, (E\text{-}V) \left(\frac{2\,\pi}{h}\right)^2 \psi = 0 \quad \text{.......} \quad (19)$$

This is the fundemental equation of wave mechanics. Here (y) is the wave function.

If we assume that external forces are nanexistant than (V) may be assumed zero. Under these conditions Schrödinger wave equation may be expressed by equation (20).

$$\Delta^2\psi + m\, E\, \frac{8\,\pi^2}{h^2}\, \psi = 0 \quad \text{.......} \quad (20)$$

As

$$m\, E\, \frac{8\,\pi^2}{h^2} = k^2$$

equation (20) may be written in the form of equation (21)

$$\Delta^2 \psi + k^2 \psi = 0 \quad \text{.......} \quad (21)$$

If this function is integrated for plane wave conditions, for positive x direction we obtain relation (22)

$$\psi = A\, e^{ik\,x} \quad \text{.......} \quad (22)$$

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ANKARA'DA PERİYODİK OLARAK YAĞIŞLA BİRLİKTE YAĞAN TOPRAKLARIN (TOZLARIN) ÖZELLİKLERİ VE KÖKENİ ÜZERİNDE BİR ÇALIŞMA

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ÖZET. — 16 nisan 1976 günü Ankara'ya sarımsı renkli bir çamur yağmıştır. Bu tür olayların geçmişte Ankara'da sıkça görüldüğü bilinmektedir. Yağışın sadece Ankara'da olmayıp, Ankara ile Akdeniz şeridi arasında da görülmesi ve o günkü meteorolojik kayıtlara göre, materyelin, Afrika'dan getirilmiş olabileceğini kanıtlamaktadır, Materyelin minera lojik ve kimyasal yapısı incelenmiş ve lös benzeri kaolinit minerallerince zengin bir materyel olduğu sonucuna varılmıştır. Yağışın büyüklüğü ve yayılma alanı ileriki çalışmalarla saptanabilirse, olayın Türk topraklarının kökeni üzerine olan etkileri de belirlenebilir.

GİRİŞ

Genellikle nisan ayının ilk yarısında periyodik olarak Ankara'da yağışlarla birlikte toprak yağdığını, tüm Ankaralılar hatırlayabilirler.

Elde edilen kayıtlara göre, bugüne kadar Ankara'da saptanmış olan toz yağmuru 16 nisan 1957 tarihinde olmuştur (Akalan, 1957). Bu tarihten sonra Ankara Meteoroloji Genel Müdürlüğünce saptanan iki önemli toz yağmuru daha olmuştur. Bunlardan birisi 27 ,mart 1969, diğeri ise 16 nisan 1976 dır. Bilinen bu üç toz yağışında, Afrika çöllerinden kopup gelen rüzgârların etkili olduğu söylenmektedir. Taşınan ve yağan materyelin gerek mineralojik gerekse kimyasal özellikleri hakkında bugüne kadar hiç bir bilgi elde edilmemiştir. Bu çalışma, son yağıştan (16 nisan 1976) sonra toplanan örneklerin analizleriyle taşınan materyellerin özellikleri ve kaynaklarını saptamak amacıyle yapılmıştır. Elde başkaca veri olmadığı için karşılaştırma yapma olanağı bulunmamaktadır. Bu çalışmayla birlikte, gelecekte meydana gelecek yağışlardan alınacak örneklerle karşılaştırma yapılarak, yağan materyelin kökeni hakkında ayrıntılı bilgiler ortaya çıkacaktır.

Bugünkü bilgilerimizle bu tür toz yağmurlarının Ankara kenti yaşamına ne gibi zararlar verdiği, ya da tarımsal alanlarda ne gibi yarar ve zarar sağladığını söyleme olanağı bulunmamaktadır.

Bazı araştırıcılar (Macleod), Kuzey Akdeniz Bölgesindeki kırmızı Akdeniz topraklarının ana materyelinin en azından bir bölümünün Sirocco adı verilen rüzgârlarla Kuzey Afrika'dan taşınarak geldiğini bildirmektedir. Bu görüş kesinlik kazanmamış olmakla birlikte, periyodik olarak Ankara kentimize kadar etkisini sürdüren toz yağmurlarının ülkemiz topraklarının oluşumunda, az da olsa etkili olacağı fikrini uyandırmaktadır.

LİTERATÜR ÖZETİ

Ankara'da periyodik olarak meydana gelen toprak yağması ile ilgili ilk eser «Uçan topraklar» adiyle Akalan (1957) tarafından yayınlanmıştır. Eserde 16 nisan 1957 tarihinde saptanan olay hakkında gözlemler yer almaktadır. 27 mart 1969 tarihli olay hakkında Devlet Meteoroloji işleri Genel Müdürlüğünün geniş bir raporu bulunmaktadır. Bu raporda' o gün yağan toprağın, Afrika'daki çöllerden atmosfere ulaşan tozların kuvvetli ve yönlü rüzgârlarla ülkemize geldiği belirtilmektedir.

16 nisan 1976 tarihli olayda ise, yine aynı kuruluşun özel raporuyle birlikte Milliyet, Hürriyet, Tercüman ve Haber gazetelerinde olayla ilgi geniş bilgiler yer almıştır. 17 nisan tarihli Milliyet o gün «Ankara'ya pembe çamur yağdı», Hürriyet «çamur yağdı», Tercüman «Ankara ve çevresinde dün yağmurla birlikte çamur yağdı», Haber «Afrika üzerinden gelen yağışlı hava kitlesi Ankara, Antalya, ve Isparta ile bazı ilçelerde çamur yağmasına yol açmıştır» başlıklarını kullanmışlardır.

Ancak yağan materyelin niteliği hakkında elimizde henüz herhangi bir kayıt bulunmamaktadır.

Yurt dışı kaynaklar üzerinde yapılan etütlere göre, Aberdeen Üniversitesinden Macleod'un Yunanistan'ın Epir bölgesinde yaptığı çalışmalar dikkat çekici bulunmaktadır. Araştırıcı bu bölgedeki kırmızı Akdeniz topraklarının bir kısmının Sirocco rüzgârları ile Afrika'dan getirildiğini savunmaktadır.

Yağmur sularında çözünen ya da süspanse halde bulunan maddelerin analizi ilginç sonuçlar ortaya çıkarmaktadır. Konuyla yakın olması nedeniyle Yaalon (1963), Yaalon (1964) ile Yaalon ve Ganor'un (1968) çalışmaları ilgi çekicidir. Bu çalışmalarda yağmurla gelen materyelin topraklar üzerinde ne gibi etkiler yaptığı açıklanmaktadır.

MATERYEL VE METOT

Bu çalışmada kullanılan materyel, 16 nisan 1976 günü yağmurla birlikte yağan çamurdan alınmıştır. Çamurun en iyi bir biçimde orijinal olmasına özen gösterilmiş, özellikle toprakla yakından bağlantısı bulunmayan kuytu yerler, açık metalik yüzeyler, araba camlarının alt köşeleri yer olarak seçilmiştir. Özenle toplanan materyel miktarı 20 gr ı bulmuş ve aşağıda belirtilen analizler bu örnek üzerinde sürdürülmüştür. Daha fazla örnek sağlamak için Devlet Meteoroloji İşleri Genel Müdürlüğüne başvurulmuştur. Ancak bu kurumun plüvyometreleri daha önceki günlerden kalan materyellerle karışık durumda olduğu için, büyük oranda çamur içeren bu örnek kullanılamamıştır.

Toplanan örneklerde aşağıdaki analizler yapılmıştır:

1. Renk: Munsel renk ıskalasına göre, hava kurusu materyel üzerinde saptanmıştır.

2. Tane büyüklüğü dağılımı: örneğin az olması nedeniyle alınan belli kısım örnek, disperse edildikten sonra, önce 0.25, 0.18, 0.105 ve 0.053 mm lik eleklerden geçirilmiş (ıslak eleme), tartılmış, böylece >0.25, 0.25-0.18, 0.18-0.105 ve 0.105-0.053 mm lik kum fraksiyonları bulunmuştur. Geriye kalan örneklerdeki kil ile silt fraksiyonu, santrfüj metodu ile birbirinden ayırt edilmiştir.

3. Mineralojik analizler: Kum fraksiyonlarından 0.105-0.053 mm arasında bulunanlar petrografik mikroskopla incelenmiş ve mineral sayımı yoluyle, belirtilen tane boyu içinde normal oranlan saptanmıştır. Kil fraksiyonunun mineralojik yapısını incelemek için Jackson'da (1965) belirtilen esaslardan yararlanılmıştır. Kil fraksiyonu süspansiyonda elde edilmiştir. Daha sonra da killer Mg^{++} ve K^{+} tozlarıyle doyurulmuş ve adi cam lam üzerine oriyente edilmişlerdir. Bu işlemlerden sonra lamlar X ışını cihazına yerleştirilerek kırınımları ve elde edilen eğrilerden cins ve yaklaşık oranlan bulunmuştur.

4. Kireç oranı: örneğin fazla oranda içerdiği toplam karbonatların oransal değerlerim bulmak için Scheibler kalsimetresi kullanılmıştır.

5. Yanma eksilmesi: Fırın kurusu 1 gr toprak, 900°C de yarım saat bırakıldıktan sonra, gravimetrik olarak saptanmıştır.

6. Tam analizi: örneğin tam analizi için Black'te (1965) gösterildiği şekilde bir hazırlama yöntemi uygulanmıştır. Fe, Ti, AI, Ca, Mg, K, Na, Mn analizinde kullanılan ana çözelti HF ergitmesiyle elde edilmiştir (Jackson, 1958). Silis ayrı bir örnekte Black'te (1965) belirtilen esaslara göre kolorimetrik yöntemle analiz edilmiştir. Renk okuması 650 mu da Spectronic 20 Bausch-Lomb kolorimetresinde yapılmıştır.

7. Toplam fosfor analizi: Vanado-molibdo-fosforik asit metodu uygulanmıştır (Kitson & Mellon, 1944).

ARAŞTIRMA SONUÇLARI VE TARTIŞMA

Hangi yönden olursa olsun topraktan atmosfere karışıp tekrar yeryüzüne dönen materyeller hakkında bilgi elde edilmesi toprak biliminde pek çekici olan konular arasında yer alamamıştır. Yağmur suları analizleriyle ilgili olarak ülkemizde yapılmış bir çalışma bulunmamaktadır. Böylece ülkemiz koşullarında hava ile toprak arasındaki alışverişin neler olduğu bilinmemektedir. Bu bakımdan bu alandaki çalışmaların ilki olarak, bundan sonraki çalışmaları teşvik edeceği ümit edilir.

Toplanan materyellerin tam analiz sonuçları (Tablo 1), ıslak eleme ile yapılan tane analizleri sonuçlan (Tablo 2), 0.105-0.053 mm arasındaki fraksiyonda mineralojik bileşim (Tablo 3), kil mineralleri çeşit ve oranlan ile diğer özellikler (Tablo 4, Şek. 1 ve 2) aşağıda verilmiştir:

Tablo 1 - 105°C de kurutulmuş materyelin toplam analiz sonuçları (% olarak)

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	Mn_3O_4	P_2O_5	CO_2	H_2O	Toplam
42.35	7.41	8.04	16.12	4.25	0.50	1.87	0.11	0.10	0.17	12.33	6.50	99.75

Tablo 2 - Islak eleme ile yapılan mekanik analiz sonuçları

Tane büyüklüğü (mm)	%
0.25	3.93
>0.25 - 0.18	1.50
0.18 - 0.105	3.84
0.105 - 0.53	10.35
Toplam	19.80
<0.053	80.2 (kil+silt)

Tablo 3 - 0.105-0.053 mm arasındaki fraksiyonda petrografik mikroskopla yapılan mineral sayımı sonuçları

	Mineral sayısı	*Mineral (%)*
Ayrışmış[1] (ağır ve hafif mineraller)	205	46.2
Opak mineraller	72	16.2
Kuvars[2]	70	15.8
Kalsit (şekilsiz ve ince taneli)	67	15.1
Feldispatlar[3]	30	6.7
Toplam	444	100.0

[1] Ayrışmış ve optik yönden tanınan ve yüzdeye girmeyen çok önemsiz oranda hipersten, titanit ve epidotta bulunmaktadır.

[2] Kuvarsın % 50 si çözünmeye uğramış.

[3] Feldispatların % 25 i kısmen ayrışmış, % 10 u tamamen ayrışmış, % 65 i ise ayrışmamıştır.

Tablo 4 - Materyelin kil mineralleri, çeşitleri ve oranları ile $CaCO_3$ oranı ve kuru iken Munsel renk ıskalasına göre rengi

Kil mineralleri	*$CaCO_3$ (%)*	*Renk (kuru)*
Kaolinit***	28.02	7.5 YR 8/4
İllit**		(açık sarımsı
Vermikülit*		portakal rengi)

* Az.
** İllit.
*** Vermikülit.

Kil mineralleri arasında başat kil mineral olarak kaolinit bulunmuştur (Şek. 1,2). Kaolinitten sonra saptanan kil minerali illittir. 14 A° pik veren ve ilikten daha az oranda yer alan mineral olarak vermiküliti görmekteyiz. Bu pikin klorite ait olmadığı, 250°C ve 550°C de ısıtılmalarda 14 A° deki pikin kapanarak 10 A° pikinin artmasıyle anlaşılmaktadır. Kaolinitin başat kil minerali oluşu, incelenen toprak materyelinin ileri bir düzeyde ayrışmayı, ya da çok eski bir topraklaşmayı göstermesi bakımından ilginç bir durum ortaya koymaktadır.

Kum mineralojisi de aşırı ayrışmanın bulunduğunu doğrulamaktadır. Petrografi mikroskopunda 0.105 mm - 0.053 mm arasındaki fraksiyonun % 46.2 sinin ayrışmış (Tablo 3) olduğu bulunmuştur. Ayrıca ağır mineraller de tanınmayacak şekilde ayrışmışlardır. Bununla birlikte hafif minerallerde de yüksek ayrışma izleri görülmektedir.

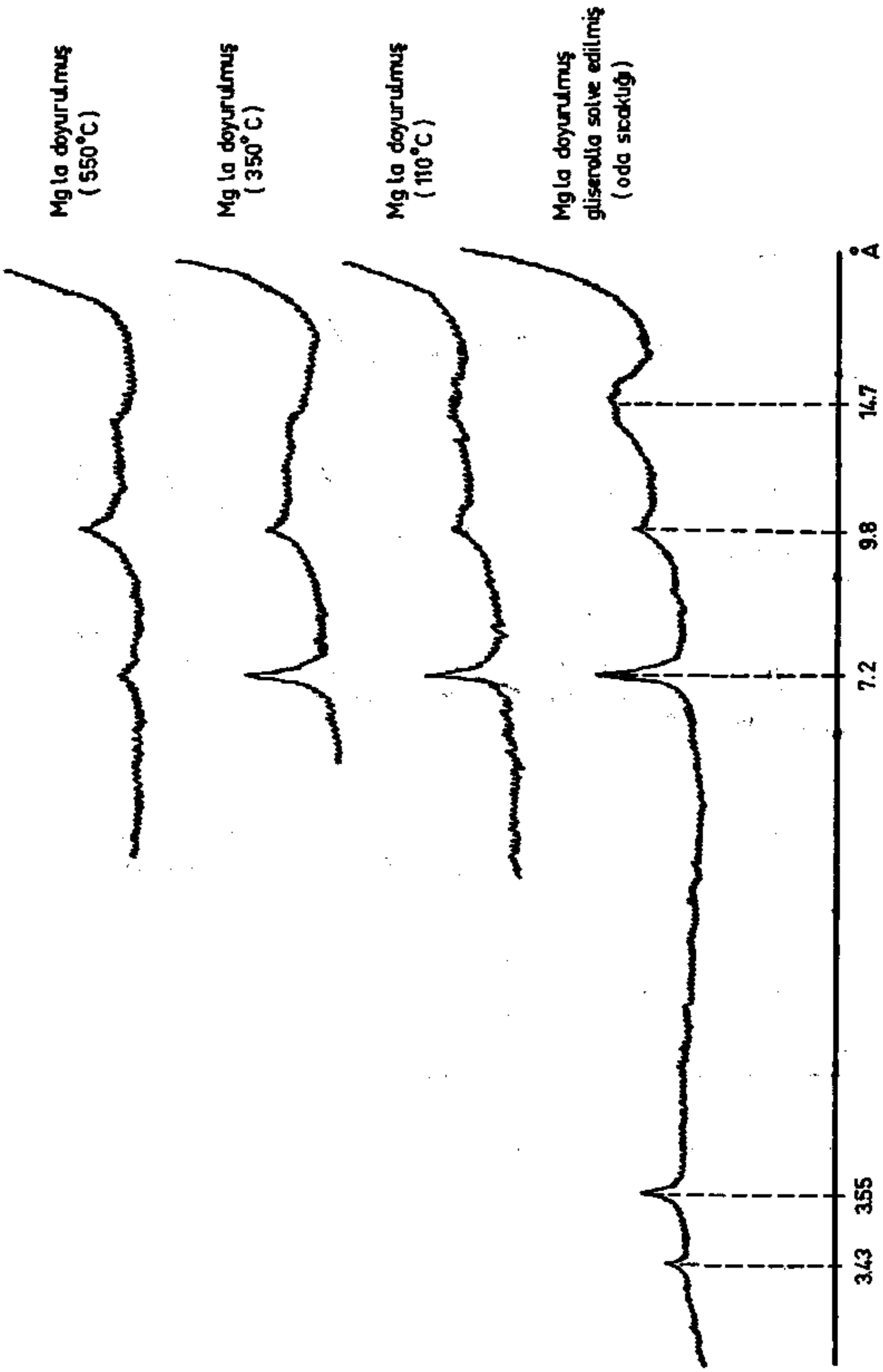
Kum fraksiyonlarında kalsitin, çoğu kez romboedrik, şekilsiz ve ince kömeç şeklinde (clustered) bulunuşu, bu minerallerin, değişik kaynaklardan gelebileceği savını düşündürmektedir.

Materyelin tane büyüklüğü dağılımı (Tablo 2), bunun bir çeşit lös benzeri bir gereç olduğu fikrini vermektedir. Bu tablodan anlaşılacağı gibi materyelin büyük çoğunluğu kil + silt büyüklüğündeki tanelerden, diğer bir deyimle tane çapları 0.053 mm nin altında olan parçacıklardan kuruludur. Bu durum materyelin uzak mesafelerden taşınmış olduğunu kanıtlamaktadır.

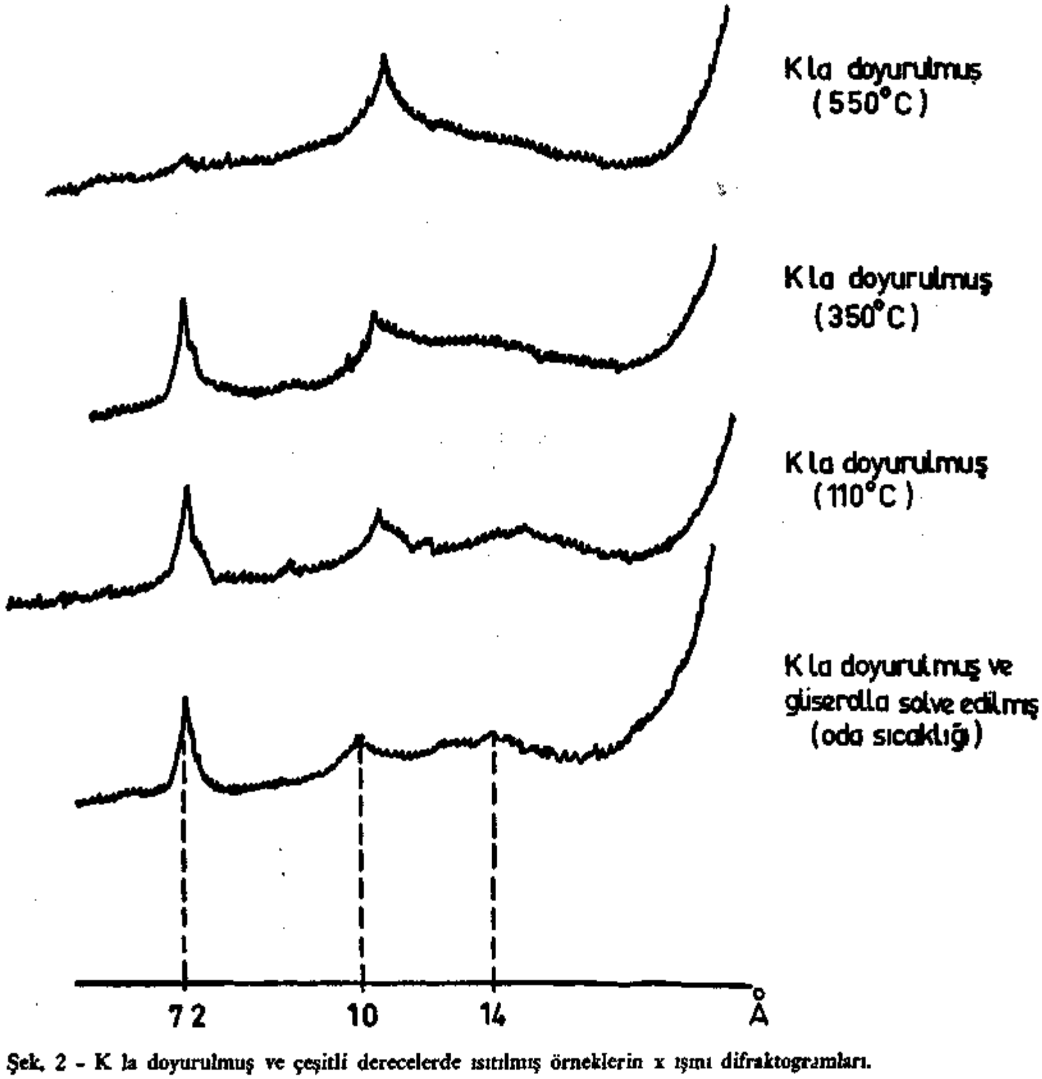
Toplam analiz sonuçlan materyelde oldukça yüksek oranda Fe_2O_3 in bulunduğunu göstermektedir. Yüksek demir oranı materyelin rengine de yansımıştır. Normal topraklara göre Mg, K ve P oranları bakımından daha zengindirler.

Özellikleri yukarıda belirtilen materyelin kökeni olması mümkün görülen Orta Afrika'dan elimizde materyel olmadığı için bir karşılaştırma yapma olanağı bulunamamıştır. Ancak materyelin mineralojisi, bunun muhtemelen Orta Afrika'nın çeşitli yönlerinden rüzgârlarla derlenip ülkemize getirilmiş olduğu savını doğrulamaktadır. Aşağıda materyeli topladığımız 16 nisan 1976 günü çeşitli gazetelerde yer alan meteorolojik açıklamalar, aynı gün D.M.İ. Genel Müdürlüğünün özel raporu, 27 mart 1969 tarihli meteorolojik bülten ve 16 nisan 1957 deki toz fırtınasının ayrıntıları ile bunların çıkardığı sonuçlar tartışılmıştır.

Akalan (1957), 16 nisan 1957 tarihli olayı şöyie anlatmaktadır: Ankara ile birlikte Orta Anadolu'da yaşayan halk bulut bulunmadığı halde, bütün gün güneşi göremediler. Hatta otomobiller farlarını yakarak hareket edebildiler. Sokaktan eve dönenler âdeta toz toprak içinde kaldıkları için, banyo yapmak zorunda kaldılar. Bu olay Orta Anadolu'da sık sık rastlanan olayların daha şiddetlisi olarak nitelenmiştir. Olay günü rüzgâr hızının 80-100 km olduğu bildirilmektedir. Aynı günkü D.M.Î. Genel Müdürlüğü rasatlarına göre, Ankara'da 9:10 - 21:30 arasında şiddetli toz fırtınası olmuş, aynı gün saat 5:35 - 6:15 arası toz fırtınası İsparta'da da görülmüştür.



Şek. 1 - Mg la doyurulmuş ve çeşitli derecelerde ısıtılmış örneklerin x ışını difraktogramları.



Şek. 2 - K la doyurulmuş ve çeşitli derecelerde ısıtılmış örneklerin x ışını difraktogramları.

27 mart 1969 günkü D.M.İ. Genel Müdürlüğü (1969) kayıtlarına göre, saat 22:30 da çamurla birlikte sağanak yağış şöyle açıklanmaktadır: Yapılan incelemelerde, çamurun Türkiye içinde herhangi bir noktadan gelemeyeceği, buna karşılık 25 mart 1969 günü saat 12:00 de Mısır'ın kuzeybatısında bir alçak basınç merkezinin görüldüğü saptanmıştır. Bu nedenle Mısır ve Libya'nın kuzey kesimlerinde yeryüzü kum ve tozlu olduğu için toz ve kum fırtınası olmuştur. Olayın olduğu gün sabah saatlarından akşam saat 18:00 e kadar Mısır ve Libya'nın kuzeyinde görüş mesafesini 300 metreye kadar düşüren toz ve kum fırtınası meydana gelmiştir. Fırtına ile havaya kaldırılan tozlar 600-850 Mb basınç düzeylerinde, diğer bir deyimle 1500-4200 m yükseklikler arasında, güney yönlerden esen rüzgârlarla Türkiye üzerine gelmiştir. Ankara'da saat 22:30 - 00.37 G.M.T. rasat edilen çamurlu yağıştan önce havada herhangi bir şey saptanmamıştır. Mersa ve Metruh'da 700 Mb basınç düzeyinde, rüzgâr hızı 65 deniz mili, Ankara'da olayın olduğu saatlarda 600 Mb basınç düzeyinde 35 deniz milidir. O halde tozların geldiği düzeyde ortalama hız 65+35/2=50 deniz milidir. Ankara Mersa-Metruh arası 675 mildir. Toplam bu yolu alabilmesi için geçen zaman 675/50=13.5 saat eder. Kuzey Afrika'da fırtına saat 9:00 da başlamış ve gerçekten de 13.5 saat sonra, yani 22:30 da Ankara'da çok oranda toz içeren yağmur yağmaya başlamıştır.

Son olarak 16 nisan 1976 tarihinde meydana gelen çamurlu yağış olayı ise, bir gün sonraki çeşitli gazetelerde de konu olmuştur. Milliyet gazetesi Ankara'ya pembe çamur yağdığını ve bu olaya Büyük Sahra'dan nemli ve yağışlı kütlelerin sebep olduğunu yazmıştır. Aynı günkü Hürriyet gazetesi, güneybatı yönlü rüzgârların çoğunlukla toz taşıdığını bildirmiştir. Haber gazetesi, Afrika'dan gelen yağışlı hava kütlelerinin Ankara-Antalya ve İsparta ile bazı ilçelerde çamur yağmasına yol açtığını yazmış ve aynı günkü Tercüman ise çamur yağma olayının 1969 yılındakine benzer olduğunu ve buna Afrika'dan kalkan toz bulutlarının neden olduğunu yeterli kaynaklara dayanarak açıklamıştır. D.M.l. Genel Müdürlüğü kayıtlarına göre ise, 16 nisan 1976 tarihinde Antalya'da çamur yağdığı belirtilmiştir. Aynı tarihte saat 12:00 de 996 Mb lık alçak basınç merkezinin Orta Anadolu'nun doğusunda yer aldığı ve rüzgârların güney yönlü olduğu bildirilmektedir.

Macleod (a,b), Avrupa'da görülen toz yağışlarının çoğunlukla Afrika'dan (Sahra'dan) geldiğini bildirmektedir. İsviçre Alpler'inde zaman zaman kar örtülerinin kırmızı renkli tozlarca kaplandığı herkesçe bilinmekte ve bunlara «kan yağmurları» ya da «çamur» adı verilmektedir. Taşınan materyelin büyük bir bölümün agregalar halinde olduğu ve yerden 3000 m yükseklikte Sirocco adı verilen rüzgârlarla taşındığı bildirilmektedir. Araştırıcı Yunanistan'ın Epirus bölgesinde bir kısım kırmızı renkli toprakların ana materyelinin de, yukarıda anılan yolla oluştuğunu savunmaktadır.

Sonuç olarak Ankara'da meydana gelen kırmızı renkli toz yağışının daha önce toprak oluşuna maruz kalmış kireçli bir materyel olduğu, bileşim yönünden bu materyelin löslere benzediği, büyük bir olasılıkla Afrika'dan ülkemize getirilmiş olduğu anlaşılmaktadır. Çeşitli özellikleri saptanan materyel hakkında daha ayrıntılı bilgilerin elde edilmesi, benzer olayların ayrıntılı bir biçimde yeniden değerlendirilmesiyle mümkündür. Ayrıca bu olayın genişliği ve ülkemiz topraklarının oluşuna etkinlik derecesinin ileriki yıllarda, ayrıntılı toprak kökeni çalışmaları için de önem taşımaktadır.

TEŞEKKÜR

Bu çalışmanın yürütülmesi sırasında meteoroljik kayıtların yeniden değerlendirilmesinde yardımlarını esirgemeyen D.M.l. Genel Müdürlüğünden Sayın Taşkın Tuna'ya teşekkürü bir borç biliriz.

Yayma verildiği tarih, 8 mayıs 1979

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ANCIENT MINERS SHOVELS AND ORE CARRIER DISCOVERED IN ESPİYE - BULANCAK AREA

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ABSTRACT. — During exploratory, drilling activities conducted by Etibank in the Giresun area in 1969, several ancient mines were discovered in Karaerik mine locality (Espiye town) and at the slag heap located near Tekmezar borough Eriklik village (Bulancak town).

The ancient miners' shovels made of the stump of an alder tree were recovered in an ancient adit discovered at Karaerik, whereas the ore carrying trough, made of chestnut, was found in an ancient gallery at the slag heap of Tekmezar borough.

The age of the ancient miners shovels and the ore carrier were determined through C-14 analyses. These findings are very important as they contribute substantially to the understanding of ancient underground mining practices carried out by the early inhabitants of Anatolia.

I. INTRODUCTION

Eastern Black Sea Region is characterized by rich copper, lead and zinc deposits. Numerous discoveries made in the present area, indicate to the fact that mining operations date back to times immemorial and had been mainly carried out to meet the copper requirements of the early inhabitants of the area. Giresun area in particular, is believed to have been the focus of intensive mining operations. Several ancient mines and slag dumps found at Karaerik mine locality, 6 kms south of Espiye and at Lahanos (formerly known as Lahnas, a typical minority village at the time of Ottoman Empire) located 15 kms south of Espiye, deserve mention in this context (Fig. 1).

It is interesting to note that Lahanos is located in an area where slags resulting from ancient copper refining activities had been dumped and it is estimated that as much as 50,000 tons of copper slag is present in the area (Topkaya, 1962). Other slag deposits, such as those found at the Karaerik mine locality (300,000 tons) (Kovenko, 1939), Karılar (15,000 tons) and Ağılık (Ağalık) (50,000 tons) are also evidences of ancient metallurgical processes carried out in the present area.

Although mention has only been made of the known slag deposits found in the Espiye area, which may be expressed in terms of several thousands of tons, similar deposits and ancient mines, are also discovered in the Giresun area. Although some authors (e.g. Kovenko, 1939) believe that the mining operations date back to 2000 B.C. in the present area, this cannot be proved due to lack of sufficient evidence. We do however know that foreign companies had started copper mining in the present area by the end of 19^{th} century (Alpay, 1954). Alpay reports that some Italian and British companies, mined copper ore in the period between 1885 and 1900. It should however be noted that to locate some of the ancient mines or to reevaluate those found is almost impossible since in the years prior to World War I and shortly after the establishment of the Republic, state sponsored research activities have unfortunately led to considerable destruction of such ancient remnants, which were further exposed to the prying of local inhabitants and natural factors. Thus the evaluation

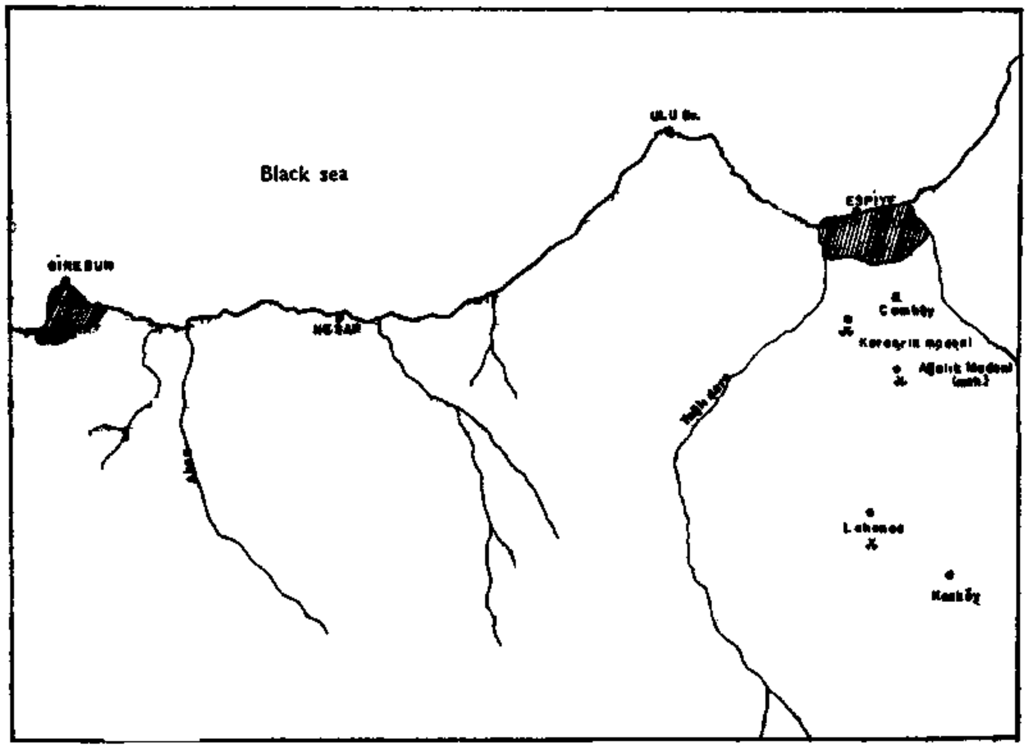

Fig. - 1

and classification ofthese ancient near-surface mines, ifnot all, is impossible. The writer believes that the ancient mines and slag deposits found in the Giresun area should be taken as an indication that the under ground mining operations and metallurgical processes have been carried out for centuries by the inbabitants of the area.

In some ancient mines, e.g. Karaerik and Tekmezar, which although destroyed coitstderably, may still be entered, ancient miners implements are found. Such ancient materials may, at present, only be osed to determine the date of mining operations within certain limits and their role and signh^-ieance in the mining history (Kovenko, 1939, 1943; Kieft, 1956).

Re - evaluation of Giresun-Tirebolu, Köprübaşı; Giresun-Espiye, and Labanos deposits, in terms of their respevtive Cu-Pb potential, bas, shown that these deposits shall continue, to maintain their significance in the future years also.

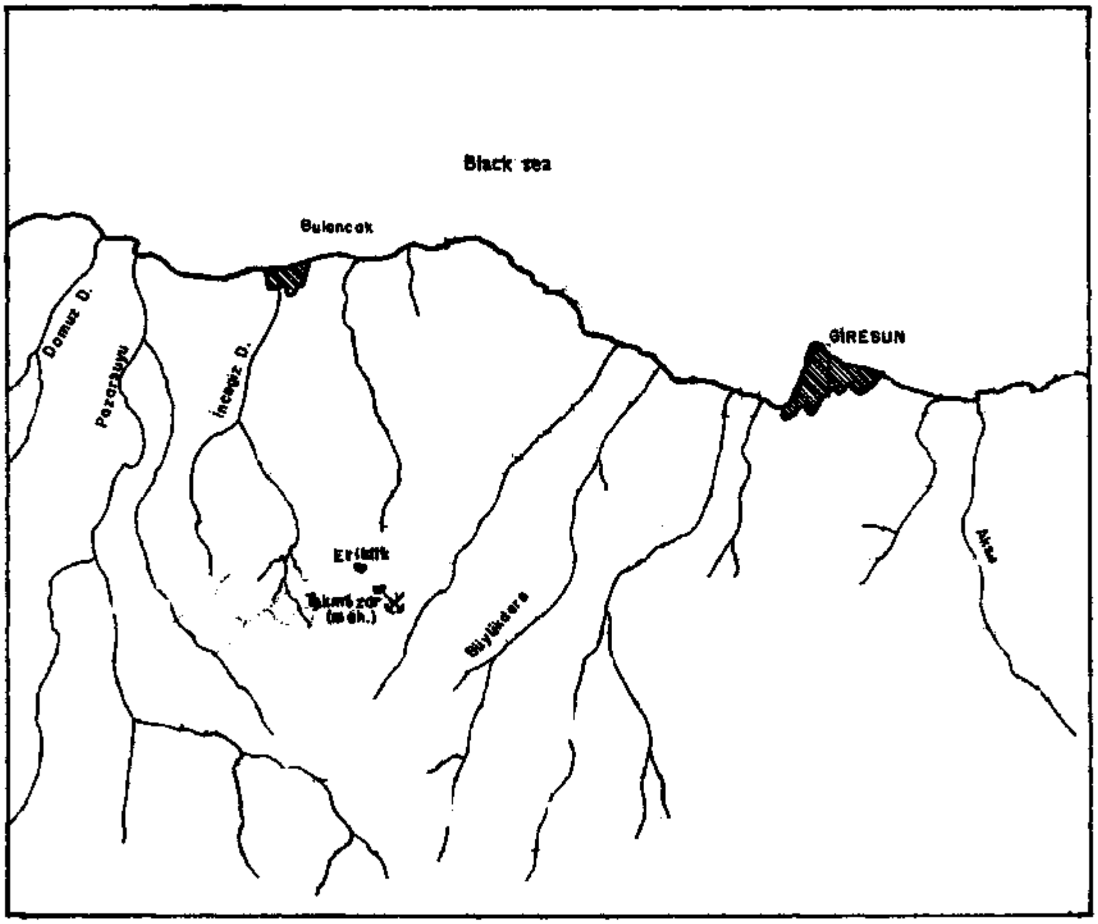

Fig. - 2

II. CLASSIFICATION OF ANCIENT MINES

Ancient mines found in some parts of Anatolia may be classified as follows:

1. Those apparently in the form of pits and penetrating a maximum depth of 10-15 meters below the surface;

2. Those apparently in the form of pits but also comprising of a narrow adit driven along the mineralized zone in the E-W or N-S direction;

3. Mines consisting of an inclined adit, driven from the surface to the maximum depth to be penetrated;

4. Mines consisting of an inclined adit driven from the surface to the maximum depth to be penetrated and step-like structures to enable the miners to penetrate further along the mineralized zone;

5. Those apparently in the form of a pit near the surface but continuing in the form of steps (Fig. 3).

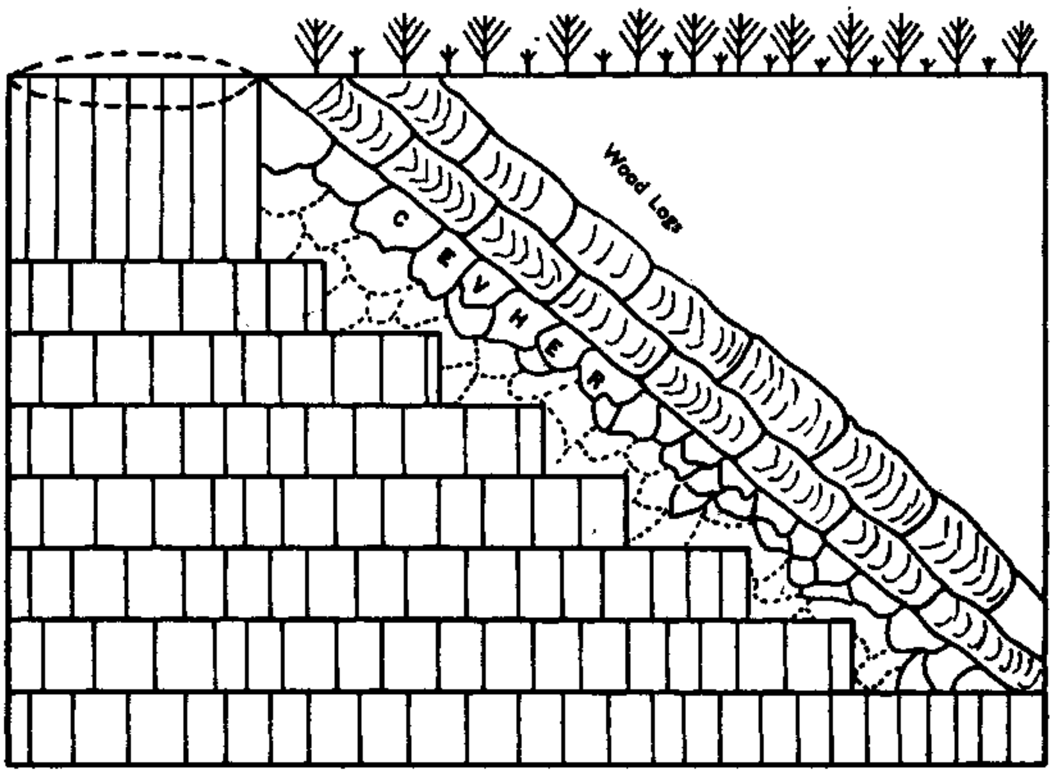

Fig. - 3

Ancient miners' implements to be discussed here were found in mines belonging to groups (3) and (4).

It is believed that the ancient miners chose to transport ore to the surface following the removal of unwanted material due to difficulties experienced during haulage and used such rocks etc., as filling material to prevent slumps in the mines.

Mines described above and the methods employed to extract ore contribute substantially to our understanding of underground mining operations carried out in Asia Minor since prehistoric times. It therefore is also possible to consider ancient ore mines in two major groups;

a) those developed in years B.C.

b) those developed in years A.D.

Ancient miners' implements discussed here were found in mines belonging to group(b).

III. SITES OF DISCOVERY

A. Espiye Materials

Karaerik mine, where ancient miners' shovels were discovered is located 6 kms south of Espiye, Giresun Province (Fig. 1).

During the exploratory drilling activities conducted by Etibank in the Karaerik mine locality in 1969, an ancient mine was discovered. The adit, approximately 100 meters long, had been driven in a chalcopyrite deposit, mined for-copper in historical times. Two miners' shovels were, found in a zone consisting of copper sulphate rocks and containing covelline minerals (Photo 1, 2), as well.

In the area under discussion a slag deposit, as mucrras 300,000 tons, was also found. Optical spectrographic semi-quantitative analyses made on the samples collected have shown the following results:

Cu 1.5 %	Pb 0.07 %
Zn 2 %	Ni 0.002 %
Fe more than 10 %	Co 0.03 %

Although on the basis of results, given above, it is difficult to conclude that the early metallurgical processes employed in the area, had been entirely directed to the production of copper ingots. The presence of several ancient mines and slag deposits, which may be expressed in thousands of tons, are concrete indications of long-lasting copper mining and refining in the area,

B. Bulancak Material

The ore carrying trough was discovered in a slag dump, located in the near vicinity of Tekmezar borough, 3 kms south of Eriklik village (Bulancak, Giresun Province) (Fig. 2).

The pre carrying trough was discovered in an ancient adit, 17 meters long, during exploratory drilling activities conducted by Etibank in the present area in 1969. The trough was recovered at a distance of 12 meters from the entry (Photo 3). The adit runs parallel the mineralized zone for 12 meters and continues in the form of step - like structures for 5 meters. Local timber had been used for reinforcement. Slag deposit located in the near vicinity of this mine is estimated to be 25 - 30,000 tons approximately.

IV. DESCRIPTION OF MATERIALS DISCOVERED

A. Espiye Materials

1. *Ancient miners' shovel (skovel-a)*

Locality of discovery : **Espiye - Karaerik mine locality.**

Item discovered : Miners' shovel (Photo 1).

Era : —

Measurements (in cm):
a. Length of blade............21.1 (Fig. 4)
b. Width of blade...............10
c. Thickness of blade.........1.3-2.5
d. Length of handle............34.6
e. Thickness of handle.......3.2
f. Total length of shovel....55.7

Characteristics: The material used in the miners' shovel discussed here is the stem of an alder tree; the quality of workmanship being good. The shovel has been preserved well as it was found immersed in copper sulphate containing ground waters. The handle and the left hand side rim of the blade are missing. Pack of the handle is hollowed inwardly for 7 cm to provide ease during handling (Fig. 4).

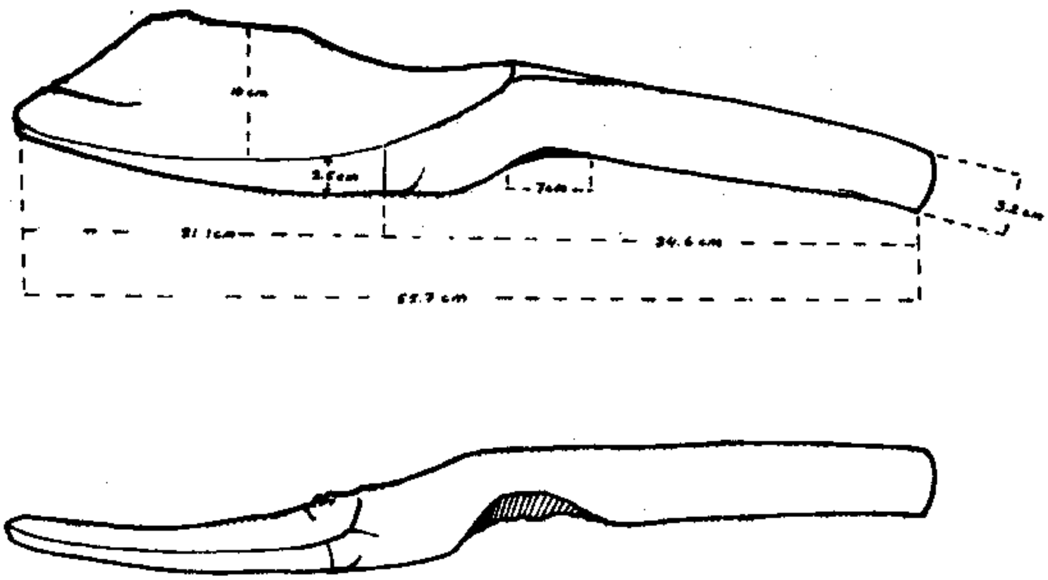

Fig. - 4

The left rim of the blade has been considerably worn out by shovelling from right to left. The concave space, as much as 7 cm long, carved on the back of the handle, facilitates handling and is large enough to make room for four fingers of a hand and is believed to have been carved by the person using the shovel.

It is further believed that the shovel had been used for a long time and on the back side in particular, the effects of copper oxides are very distinct. The traces left by the copper oxides on the back of the handle, i.e. on the concave space, are oval shaped, whereas those found on a thin section of the handle are essentially in the form of rings. The miners' shovels discovered in the present area are well-preserved against natural effects as these were found immersed in copper sulphate containing ground waters.

2. *Ancient miners' shovel (Shovel-b)*

Locality of discovery : Espiye - Karaerik mine locality.

Item discovered : Miners' shovel (Photo 2).

Era : 11-13th centuries,

Measurements (in cm) : a. Length of blade.......... 18.5 (Fig. 5)

b. Width of blade............. 11 1/2

c. Thickness of blade....... 1-1

d. Length of handle......... 58

e. Thickness of handle...... 3.5

f. Total length of shovel 76.5

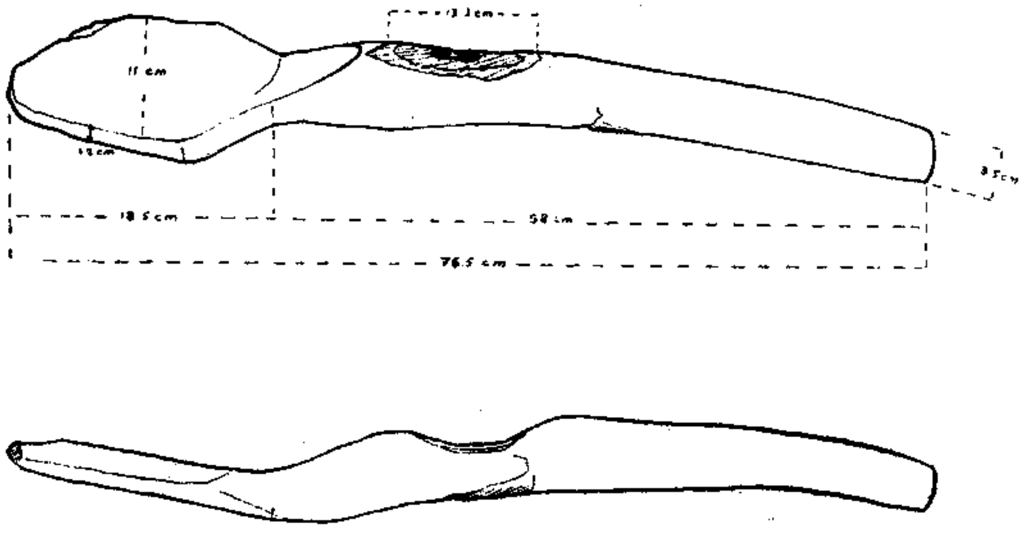

Fig. - 5

Characteristics: The material used for shovel-b, is the stem of an alder tree. The traces of copper oxide are distinct on both sides of the blade and on the handle as well. A concave hollow, as much as 13.3 cm long, had been carved on the front side of the handle. The right hand side rim of the blade is missing. Although the handle, is also missing partly, it is quite long, thus displaying a certain degree of disharmony.

3. *Comparison.* — Same type of material, i.e. stem of an alder tree, is used for both shovels. The quality of workmanship is better in shovel-a. Shovel-b, however, displays a distinct disharmony regarding the blade and the handle (Photo 2). The concave space, carved on the back of shovel-a and as much as 7 cm, appears on the front side of shovel-b and is as much as, 13.3 cm long. In shovel-a, the left hand side of the blade is worn out, which is in contrast with the fact that in shovel-b the right hand side of the blade is considerably worn out and missing. This may have been due to the fact that the miners using these shovels in ancient times, shovelled in opposite directions. It is also believed that the handles of these shovels were used, in the case of necessity, to remove the rocks and this may explain the fact-that the handles are in part missing. The handles must have been worn out and broken during such toiling. The handles would have been preserved in good condition, should they had not been used to remove and tear away boulders of rocks.

B. Bulancak Material

1. *Ore carrying trough (ore-carrier) (Photo 3)*

Locality of discovery : Slag deposit near Tekmezar borough, 3 kms S of Eriklik.

Item discovered : Ore carrying trough.

Era : ll-13th centuries.

Measurements (in cm) : a. Length........................118 (Fig. 6)

b. Width.........................24-25

c. Depth (inner)...............6.5

d. Hole diameter..............7

e. Height of holes from base......10-11

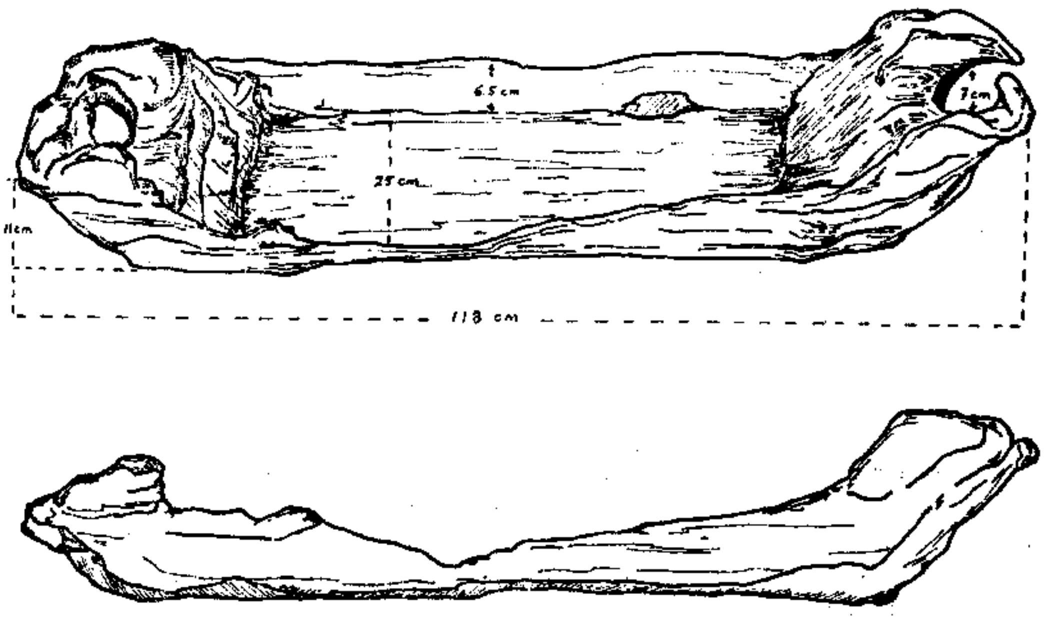

Fig. - 6

V. TECHNIQUES EMPLOYED

A. Espiye Materials

Shovels a and b are made of the stem of an alder tree, and in the part of the stump used for this purpose, the growth rings are transversally parallel on the handle and on the upper surface of the blade (Fig. 7, 8). This feature observed on the shovels emphasizes the success of the technique employed in their making, through preventing possible breaking during usage. Should the growth rings in the stump used had been longitudinally parallel, the lifetime of the shovels must have been considerably shorter. The technique employed in these shovels used by the ancient miners living in Asia Minor some 9 centuries ago, should be taken as a concrete example of the knowledge and experience possessed by the inhabitants of the area since times B.C. (5).

Fig. - 7

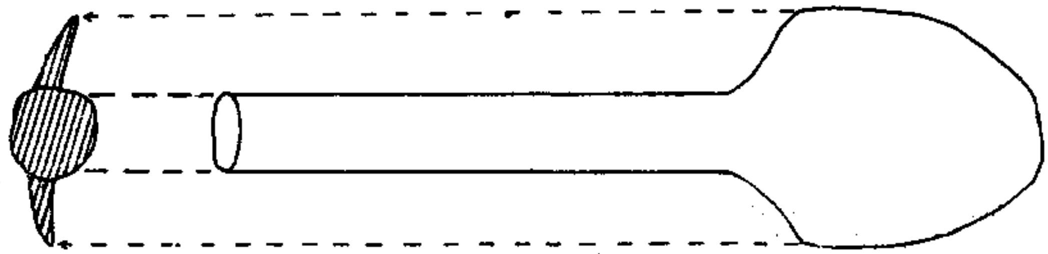

Fig. - 8

B. Bulancak Material

The material used for the ore-carrier is the kernel of a chestnut stump, split along its diameter and possibly 109-112 years old; the growth rings in the tree lie transversally parallel to the holes opened at both ends of the ore - carrier, thus imparting it strength. It is believed that the technique employed by the ancient miners in the making of the ore - carrier, has been developed through experience.

VI. AGE DETERMINATION

A. Espiye Materials

1. *Ancient Maters' Shovel (Shovel-a)*
2. *Ancient Miners' Shovel (Shovel-b)*

Both shovels are exhibited at the Mineralogy Section of the Natural History Museum of M.T.A., in a space particularly dedicated to Mining History of Turkey (inventory numbers are 76.892. a and 76.892. b). Analyses of the samples taken from shovels a and b at the laboratories of the Physics Department of the Middle East Technical University, by 5568 radioactive half - life C-14 method gave the following results:

1. Ancient miners' shovel (shovel-a)

Results obtained from the analyses of samples taken from this shovel are not reliable.

2. Ancient miners' shovel (shovel-b)

789 ± 74 before 1950 A.D.
1161 ± 74 A.D.

Samples taken from shovel-a were analyzed three times, the results obtained each case being unsatisfactory and unreliable. Although in such cases the analyses of more samples in necessary as the results to be obtained are used for comparison purposes, additional samples are not taken from shovel-a to avoid any ruin on the general form of the object in question.

The age obtained for shovel-b may also apply to shovel-a since both objects are recovered from the same locality. This assumption is further supported by the fact that the material used in both shovels is the same type oftree, i.e. alder tree. It may therefore be concluded that the Espiye - Karaerik mine and other mines located in the near vicinity had been operated by the inhabitants of Anatolia as early as the period between 11-13 th centuries the lack of additional material which may be used for further comparisons, however, prevents the determination of the exact date of first operation of these mines.

B. Bulaacak Material

1. *Ore - carrier.* — The date obtained for the ore carrier by the 5568 radioactive half- life C-14 method is given below:

958 ± 75 before 1950
992 ± 75 A.D.

VII. COMPARISON WITH SIMILAR FINDINGS

A. Espiye **Materials**

Ancient miners' shovels found in Karaerik mine, may be compared with the ancient miners' shovel discovered in Anayatak, Murgul mine, dated to belong to the second half of the first millenium B.C. It must however, be noted that the shovels discovered in the Karaerik mine area, date back to 900 years ago, and in contrast to the low quality of workmanship of the shovel found in Anayatak, ancient miners' shovels a and b, found in Karaerik display a higher quality of workmanship, and may be compared with the modem shovels. In Figure 4, details of shovel-a (Photo 1) are shown. Shovel-b, which differs from shovel-a in its shape and workmanship, is shown in Figure 5 (also Photo 2).

Hollow spaces carved on the handles of both shovels (Fig. 4, 5), facilitate handling. These characteristics, however, are absent in the ancient miners' shovel discovered in Anayatak, Murgul mine. The only common feature of the ancient miners' shovels discovered in Anayatak and in Karaerik, is that both are made to be used for the same purpose, although they belong to entirely different centuries. Another common feature of these shovels, is the material, i.e. stump of a tree, used in their making.

B; Bulancak Material

The age obtained for the ore - carrying trough by C-14 method cannot be confirmed due to lack of other similar findings, which would otherwise have served for comparison purposes also. Thus it may be concluded that the ore - carrier is unique, as it represents the only discovery of this type, made in Turkey.

VIII.CONCLUSIONS

The shovels and the ore carrier discovered in the ancient mines, of Espiye and Bulancak areas and made of alder and chestnut respectively, suggest that the ore deposits located in the Giresun area as a whole, had been mined by the inhabitants of the region in the period between the 11th. and 13th conturies.

The ore carrying trough is, on the basis of material available, unique since k is the only discovery made of this type. It is. also presumed that the ore carrier described here, has been used by the aacient miners, with considerable success, in the mines comprising of inclined galleries, and may well be considered to be the prototype of the modern equipment employed for hauling proposes.

' Due to lack of similar findings the age obtained for the shovels and the ore carrier discussed here, by C-14 analyses, cannot be confirmed. It should however be noted that the age determined for the ancient miners' shovel discovered in an ancient gallery in Anayatak, Murgul mine, by C-14 method (second half of the first millenium B.C.) confirms the fact that the ore deposits located in the Eastern Black Sea Region were not only mined in the period between the 11-13[th] centuries but since pre - historic times. The age obtained for the ancient miners' shovels and the ore carrier discovered in Espiye and Bulancak, therefore, hardly reflects the date when underground mining operations were first started in the area.

Ancient mines are for the most part destroyed during modern investigations aimed to the development of new mines, thus their contribution to the understanding of mining history of Turkey, being considerably reduced. Although the materials contributing to the understanding of the mining history of Turkey are very limited, ancient miners' shovels and the ore carrying trough discovered and the slag deposits as well, emphasize the role and importance of Giresun area in the mining history of Asia Minor.

Ancient miners' shovels and the ore carrier discussed here, deserve due importance as these undoubtedly help us to understand the history of underground mining operations, from view point of materials and techniques used in their making.

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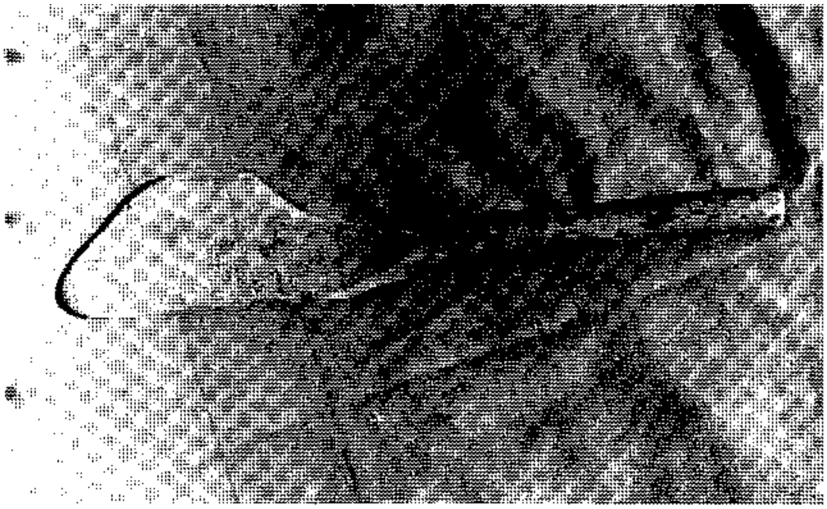

Photo 1

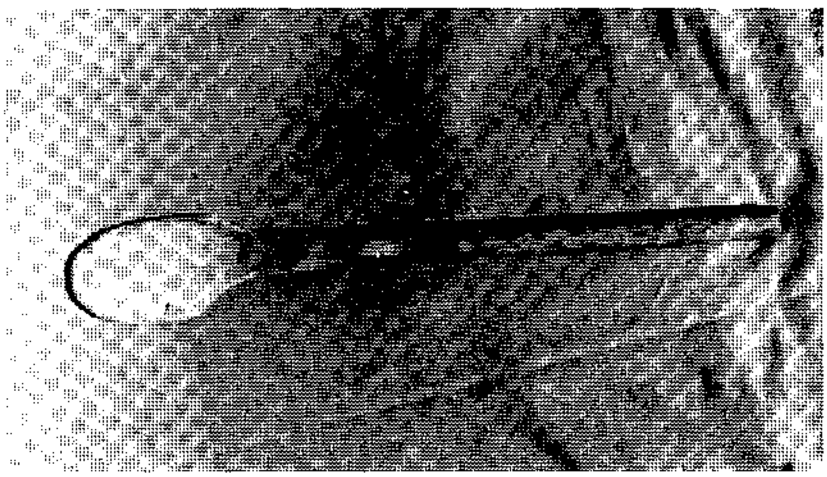

Photo 2

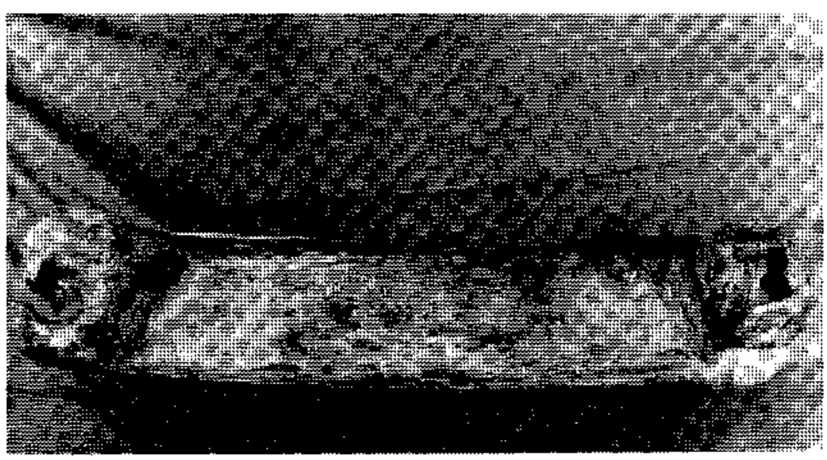

Photo 3

Paris - April 1979

Sessions of the International Geological Congress have been held every four years since 1878. The 26th session will celebrate the Centenary of this organization convened under the auspices of the International Union of Geological Sciences.

Organization Committee: Chairman : Jean AUBOUIN

Secretary General: Paul SANGNIER

Timetable: - 26 June to 5 July - Pre - congress scientific excursions
- 7 to 17 July - The Congress will meet at the Palais des Congres at Porte Maillot
- 18 to 27 July - Post - Congress scientific excursions.

Scientific program

1. *Opening scientific meeting:* Leading specialists will survey five main themes concerning the current state of scientific progress.

2. *Sections:* The proposed program covers almost the entire field of the Earth Sciences and is divided into 20 sections. The Organization Committee has also planned to have the work of the various international scientific organizations affiliated with the International Union of Geological Sciences integrated into the program of the Congress. Authors are free to choose their own subjects for communications and these should be sent to the Secretary General before 1 October 1979 for the publication of abstracts.

3. *Colloquia:* The program for the colloquia was chosen so as to illustrate the main themes of current scientific and economic interest. There will be seven in all and they will be chaired by leading scientific figures. Communications to the Colloquia are made by invitation only.

Excursions

The Organization Committee in association with the National Committees for Geology of 18 european countries has organized an attractive program of geological excursions. The chosen themes make it possible to offer Congress participants a survey of all aspects of the geology of Western Europe. 85 different excursions each lasting for 9 days are planned from 26 June to 6 July 1980 or from 19 July to 26 July 1980. Since only a limited number of persons can participate in the excursions the places will be reserved by the Organizing Committee in October 1979 in the order in which the reservation forms were received.

Exhibition

An exhibition to be called «GEOEXPO 80» will be held in the same premises as the Congress from 7 to 11 July 1980. It will be open to all international institutions and will make it possible for exchanges of ideas and contacts to take" place with scientists from all over the world.

Social Program

Since e Congr is taking place in Paris the organizers will be able to plan a very attractive program for the participants and a special program for persons accompanying them.

State of advancement of con paration

80.000 copies of the first circular were sent out in october 1977. By 1 december 1978 the Organization Committee had received 5,800 answers from 114 different countries and 4,000 persons had asked to take part in the excursions. The second circular is now availabe and contains the final registration form.

Those interested in participating in the Congress and wishing to the second circular should request it from the:

Secretariat General du 26 eme Congres Geologique International

Maison de la Geologique

77-79, rue Claude Bernand

75005 PARIS - FRANCE