DISCUSSIONS ON THE METAMORPHIC MAP OF TURKEY IN A SCALE OF 1:2,500,000 AND GEOTECTONIC EVOLUTION OF SOME METAMORPHIC BELTS

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ABSTRACT. — Metamorphic rocks belonging to the same facies and age occur in well-defined belts in Turkey. This fact should be considered as one of the data of major importance which is to be taken into consideration in the study of the geotectonic evolution of Turkey. In the present paper the metamorphism and geotectonic evolution of the metamorphic belts of Turkey are discussed.

INTRODUCTION

Based on the available data, much has been published to describe the crystalline areas in general, as well as the metamorphic effects prevailing in Turkey, using 1:2,500,000 or smaller scale maps covering large portions, or the whole of Turkey. During preparation of the 1:2,500,000 scale Metamorphic Map of Turkey (Fig. 1), which is the main concern of the present paper, 1:4,000,000 scale Magmatic Map and 1:2,500,000 scale Tectonic Map (Ketin, 1961-1966), 1:500,000 scale Geologic Map of Turkey (published by the M.T.A. Institute) and the 1:2,500,000 scale Geological Map of Turkey, showing the distribution of blue schists in Central and Western Turkey (Kaaden, 1966), as well as smaller scale maps showing metamorphism (Brinkmann, 1971) were used.

1:2,500,000 scale Metamorphic Map of Turkey was prepared to be used in the Metamorphic Map of Europe, again of 1:2,500,000 scale (Fig. 1).

As it will be clearly noticed on the map, metamorphic rocks of similar age and facies occur in well defined belts. This characteristic feature, therefore, must be duly taken into consideration in the study of the geological development of Turkey.

In the present paper, the writer will briefly discuss the most interesting features observed in these belts. He will not attempt to make elaborate syntheses based on their occurrence, since necessary data is not yet available to do this.

INTERESTING FEATURES OF THE BELTS — DISCUSSIONS

a. Kargı Metamorphites

The Kargı Metamorphites (Fig. 1) are shown as a region where rocks transitional from glaucophane facies to green schist facies are predominant. Metamorphic rocks occurring in the Black Sea Belt, however, are no doubt of Precambrian age, since they are unconformably overlain by Cambrian. Ordovician rocks and medium-pressure amphibolite facies rocks are very widespread in this area. For instance, in the areas to the west and south of Kastamonu, located close to the Kargı Metamorphites, the Precambrian metamorphic rocks of the medium-pressure amphibolite facies are overlain by

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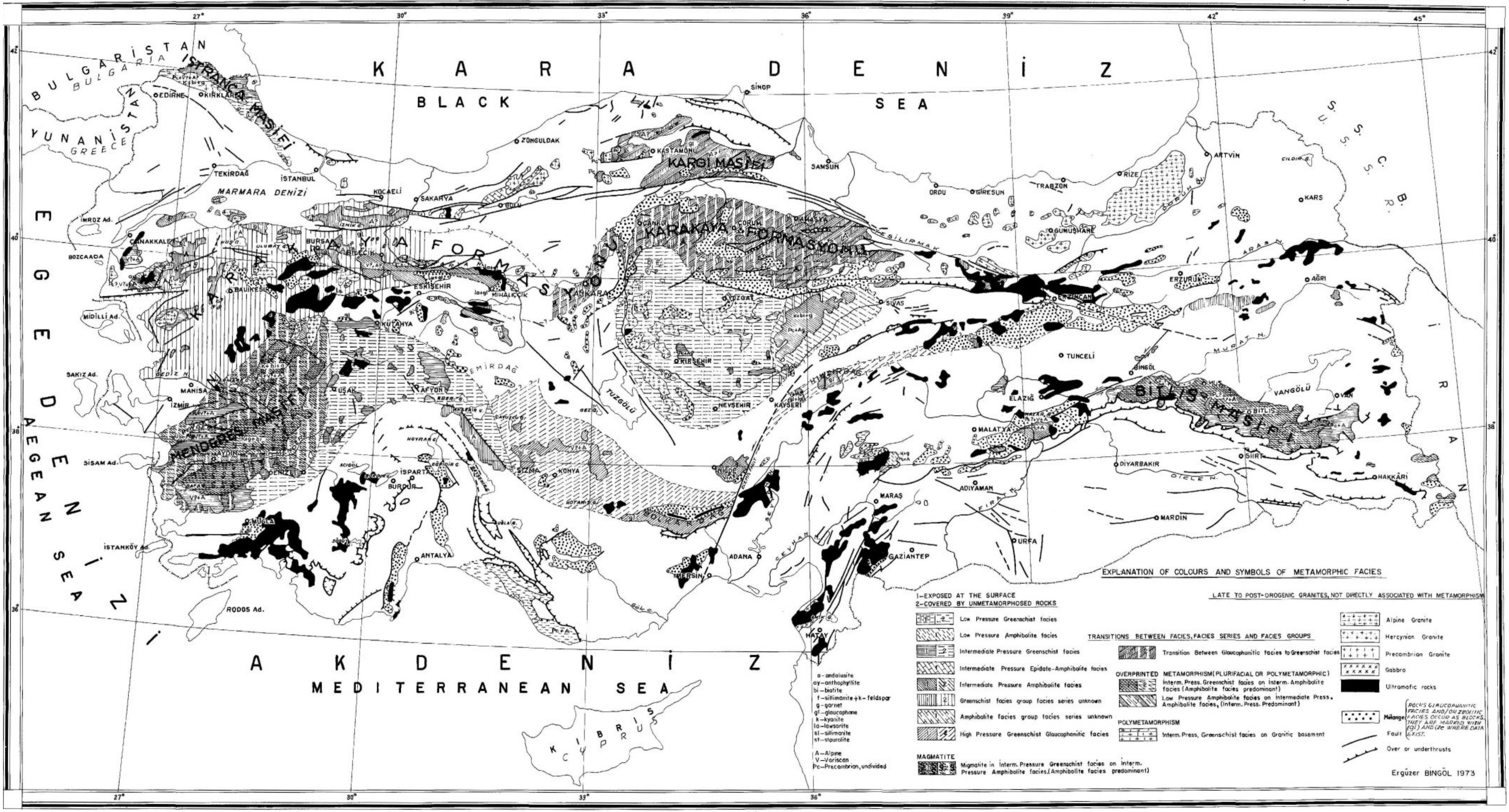
METAMORPHIC MAP OF TURKEY



1/2 500 000
Fig. 1

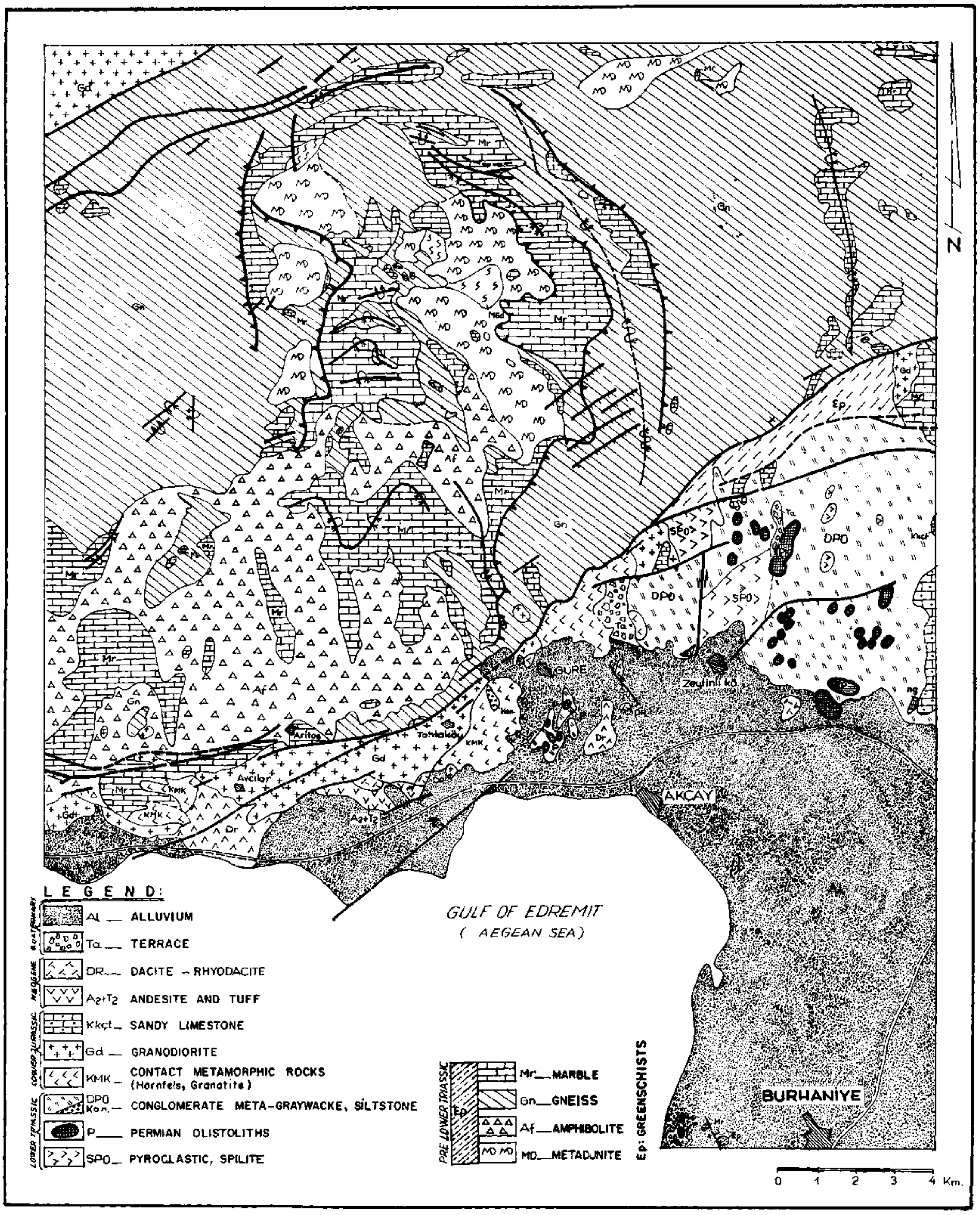


Fig. 2 - Geological map of Kazdağ region (After BİNGÖL, 1968-1971).

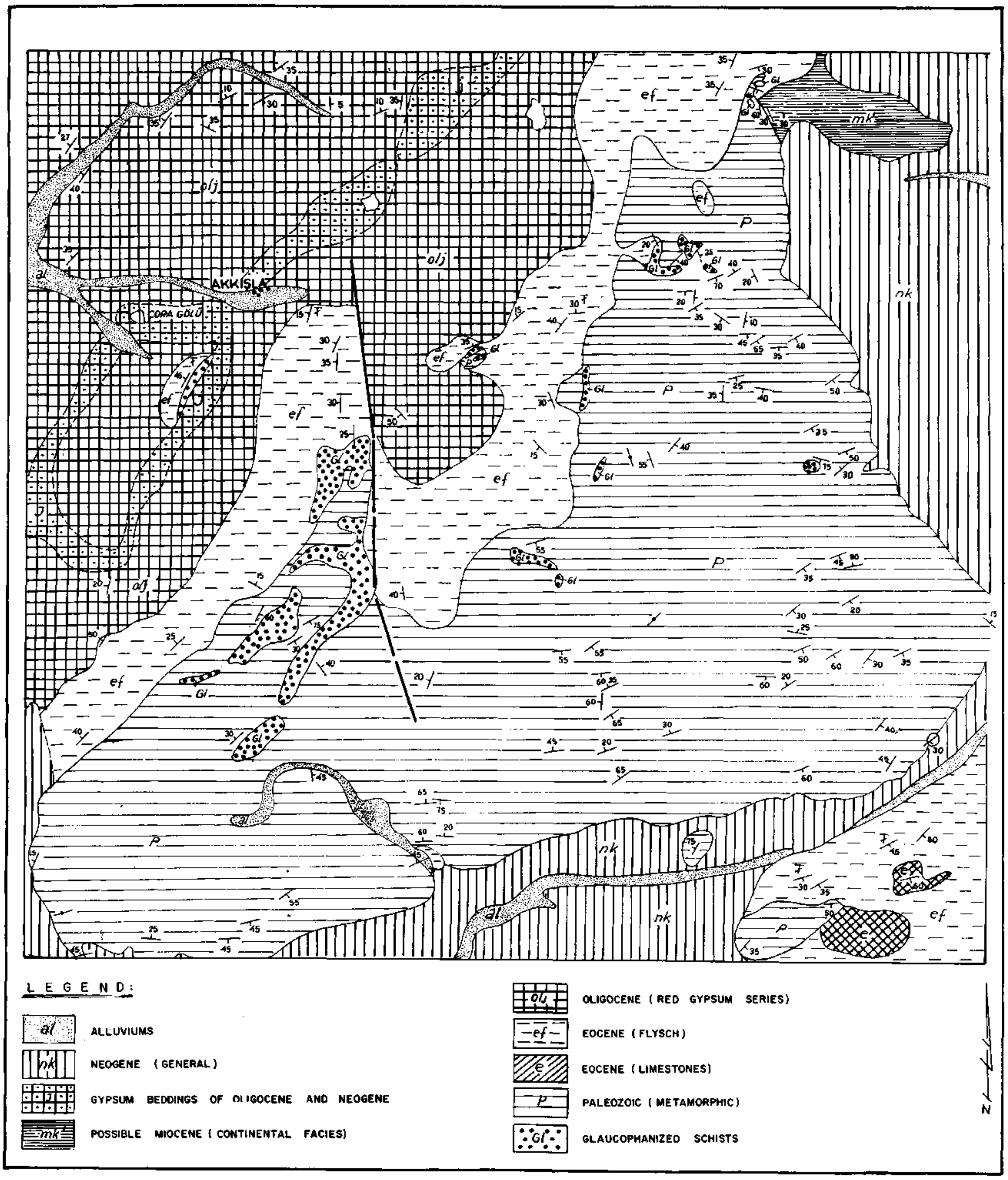


Fig. 3 - Geological map of Hınzırdağ region (After LEBKÜCHNER, 1958).

a thick sedimentary cover. This being the case, it means that the Kargı Metamorphites and the metamorphic rocks forming the depositional basement are quite foreign to one another. This configuration strongly suggests that the Kargı Metamorphites were transported from other places, i.e. they are allochthonous. The occasional presence of ophiolites and typical melange in the Kargı Metamorphites strongly supports the assumption that the metamorphic mass observed in the area is, in fact, a part of a thrust sheet.

b. Karakaya Formation

South of the North Anatolian Fault, mainly in the vicinity of Amasya, is a belt of metaspillite and metagraywackes containing large blocks of limestone and green schist. The belt is also observed in the vicinity of the Ankara-Bilecik-Bursa-Balıkesir and Manisa areas (Bingöl, 1968-1971; Bingöl, Akyürek & Korkmazer, 1973). Fossils in most of the limestone blocks were destroyed by recrystallization. Associated schists, on the other hand, often display the characteristic features of a medium-pressure green schist facies with glaucophane present only here and there. Lithological features, as well as faunal content, wherever preserved, indicate that the limestone was deposited in a shallow environment. Deep burial, as evidenced by the presence of glaucophane, suggests that these limestones were subjected to strong tectonic movements, before reaching such depths.

The occurrence of limestone blocks is attributable to the ingression of Permo-Carboniferous or older blocks to the depression areas, resulting from tensional stresses, which affected the Tethys region after the begining of Lower Triassic (Bingöl, Akyürek & Korkmazer, 1973). The area, although not oceanized during the pre-Lower Triassic times, was somewhat unstable and showed deep-sea character. The association of spillites and sediments leads the writer to think that the basin was related to an ocean bottom, the location of which is as yet not definitely established, but it may be assumed that it must have existed north and northwest of Menderes massif.

It should, therefore, be kept in mind that in relatively shallow waters these limestones might, where cut by reverse faults, have penetrated into the schists slightly metamorphosed, which were produced in a different environment.

Another interesting metamorphic feature of the area is the occurrence of medium-pressure green schist facies, together with the glaucophane facies. This may be attributed to the fact that the rocks metamorphosed in the high-pressure green schist facies lost their typical glaucophane facies minerals when exposed to relatively higher temperatures at greater depths and they progressively gained the characteristic features of the medium-pressure green schist facies. This assumption is further supported by the occurrence of younger acidic intrusive and extrusive rocks as well as typical glaucophane facies along the belt."

c. Kazdağ Massif

Metamorphic effects observed in the Kazdağ Massif were studied in detail (Bingöl, 1968-1971). Metadunite, metagabbro, pyroxenite, amphibolite gneiss and marble (medium-pressure amphibolite facies), as well as their medium-pressure green schist equivalents, metamorphosed probably in Precambrian, and were affected by Tertiary low-pressure metamorphism (Fig. 2). Litholbgical features of the Kazdağ Massif, differ greatly from those of the Menderes Massif.

d. Hınzır Dağları - Bolkardağ - Sızma Belt

In this area, green-colored schists, generally showing volcanic origin and intercalated with limestone bands, contain typical mineral suites belonging to the glaucophane facies. The belt is best seen in Bolkardağ (Demirtaşlı *et al.*, 1973), İzmir Dağları (Lebküchner, 1957) (Fig. 3) and Sızma area (Wiesner & Lehnert-Thiel, 1964; Bayiç, 1968) (Fig. 4).

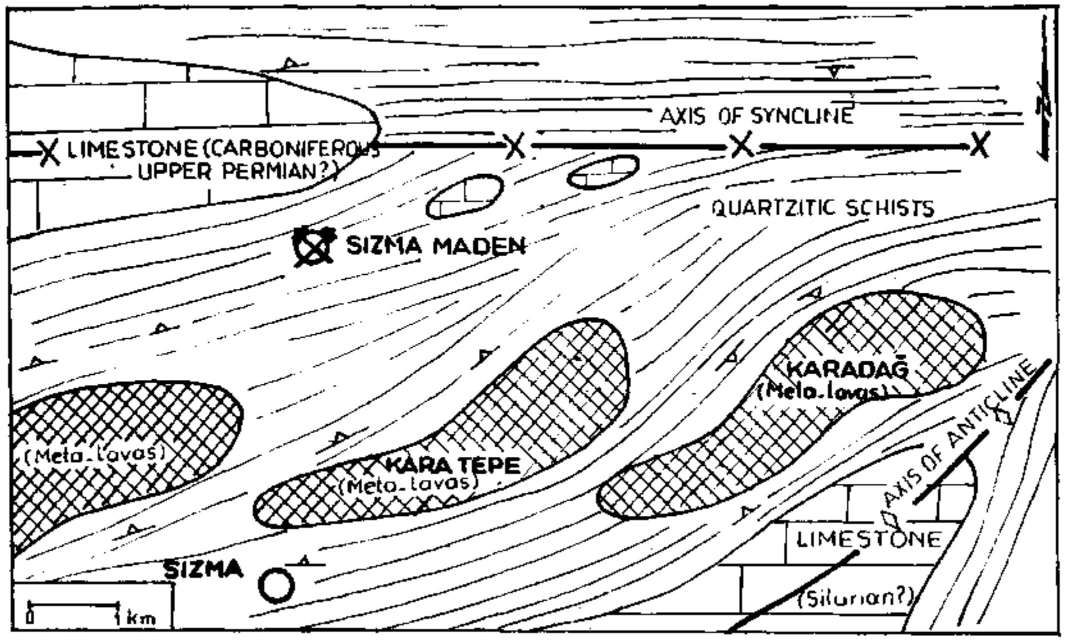


Fig. 4 - Geological sketch-map (after Wiesner & Lehnert-Thiel, 1964).

It is commonly thought that the limestones and the associated schists were not transported to the area by tectonic movements or by gravity slides, as is the case in the Karakaya formation. That means, limestone intercalations were affected by the same metamorphism, where glaucophane minerals were formed in the schists. These slightly metamorphosed limestones are of neritic facies and contain Paleozoic and Mezosoic fossils. Limestones deposited in shallow environments must have been transported to deeper horizons as necessitated by the glaucophane facies. It is interesting to note that various authors have differing ideas in regard to the formation of the glaucophane facies. Winkler (1967) suggests a depth of 30-40 km, whereas Gresens (1970) thinks that the blue schists were formed metasomatically at relatively shallow depths.

That the burial occurred in the area, just where the belt now extends, seems impossible since it implies a vertical dislocation ranging between 30-40 km. Thus it follows that either the belt is allochthonous and was transported to the area by strong lateral movements, or that the formation of glaucophane facies was primarily due to metasomatic processes taking place in relatively shallow depths.

The left-lateral displacement of the Ecemis fault is well exposed due to the dislocation mentioned above and it ranges between 80-90 km.

e. Emirdağ-Kütahya-Eskişehir-Balıkesir Melange Belt

The NW extension of the Hınzırdağ-Bolkar-Sızma Belt contains larger zones. It is interesting to note that the melanges occurring in this area contain blue schists as well. The blue schist facies of the Mihalıççık (Fig. 5), Eskişehir and Orhaneli areas were determined based on typical paragenesis and several reports were published on this by various authors (Çoğulu, 1967; Lünel, 1967; Özkoçak, 1969; Lisenbee, 1972; Kaya, 1972). If we take into consideration the young granodioritic intrusions extending in the northern part of this area, it can be suggested that there is a subduction zone extending in a SW-NE direction in the west, and in an E-W direction

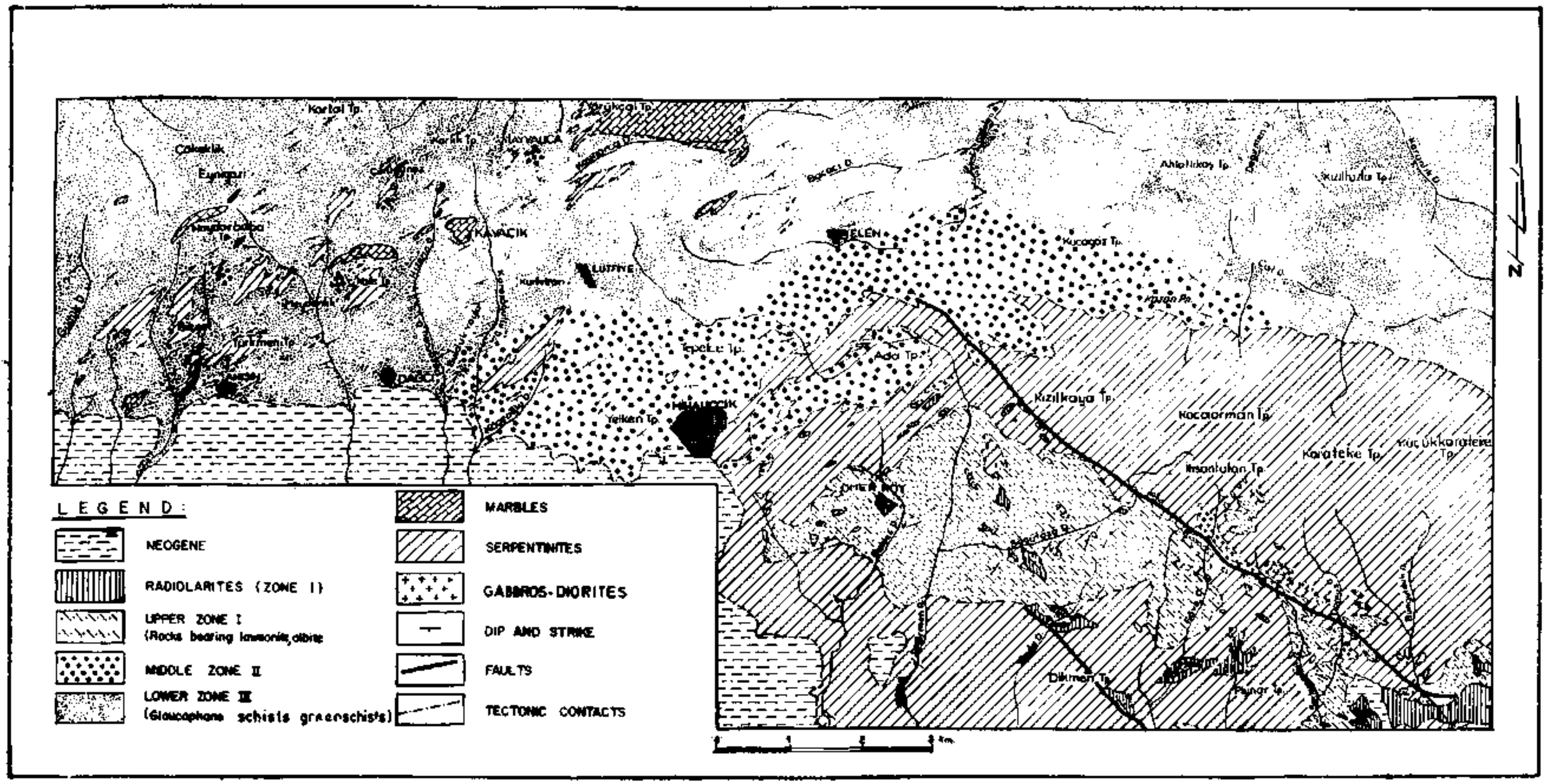


Fig. 5 - Geological map of the Mihalıççık province (after Çoğulu, 1967, simplified).

in the north. Since the area lying between Afyon and east of Kütahya was not studied in detail with respect to metamorphic effects, it may be said with some reservation that the large glaucophane-containing masses, occurring in the vicinity of Bolkardağ and Sızma areas, appear more and more to have been transformed into smaller allochthonous glaucophane-bearing masses towards NW. Another point of view, suggested on the relation between the areas showing typical melange character and the Bolkardağ region, is that the melange is partly derived from the glaucophane-bearing schists and forms the overlying cover. Data available, however, are more in favor of the first point of view, because in the region where melange zones are predominant the Mesozoic lithologies are autochthonous (Özkoçak, 1969; Lisenbee, 1972; Bingöl, 1974) and easily distinguished from the rocks which might be of the same age within the melange. In the southeast and east this melange covers, as an allochthone, the Mesozoic and older rocks.

f. Bitlis Massif

Bitlis Massif presents interesting and somewhat complex metamorphic features. Local detailed studies revealed that Paleozoic medium-pressuse amphibolite facies metamorphism occurred in association with the medium-pressure green schist Alpine metamorphism (Yılmaz, 1971; Boray, 1973). It may be presumed that recent metamorphism affected older metamorphic masses, bringing forth the complex metamorphism of the area. However, many investigators, who studied in detail this area, suggest that the metamorphic masses are bordered by thrust faults and that locally serpentines occur along these faults (Pişkin, 1972; Mason, 1973; Hall, 1973). Serpentines can also be traced to the inliers (Hall & Mason, 1972). These investigators are inclined to consider the Bitlis Massif as a metamorphic melange.

Because the data available is not conclusive, the Bitlis Massif was shown on the map as a medium-pressure green schist facies, overlying the medium-pressure amphibolite facies.

In this area, which corresponds to a compression zone located between two continental crusts, the occurrence of numerous imbricated structures and melange characteristics is expected. Therefore, it may be considered possible that the area, metamorphosed during medium-pressure amphibolite facies, was fractured due to compression and was deposited on a marine crust and that it was tectonically mixed with younger rocks which were subjected to metamorphism during the formation of medium-pressure green schist facies when compression forces were very active.

g. Menderes Massif

Various opinions were voiced for the Menderes Massif by many investigators who have studied it in the recent years. Many of them believed that the Massif consisted of a core and a cap. The core is made of a medium-pressure amphibolite zone, which from place to place displays a locally migmatitic character, while more to the east lies a low-temperature, medium-pressure green schist facies (Schuiling, 1962; Kaaden, 1966; Başarır, 1970; İzdar, 1971).

Results of radiogenic age determinations and regional studies were not conclusive. A Precambrian-Alpine age may be possible. Some investigators, however, suggest Hercynian age for the Menderes Massif (Durand, 1962 *in* İzdar, 1971).

The relation between the overlying part of the Massif and the core is not fully known. The presence of an unconformity between the core and the cover, based on lineation (Schuiling, 1962), is not adequately confirmed by data and the most distinct feature of the area is that the metamorphic effects gradually decrease from core outward. The question now is whether or not this cover formation is related to the unmetamorphosed sediments of the Taurus Mountains. Clarification of this point will considerably contribute to the understanding of the role of the Menderes Massif in the tectonic development of Turkey and will help explain the position of the Massif itself.

In spite of the incomplete data, it may be assumed that no progressive, continuous metamorphism and no transition can be expected between the cover and the core of the Menderes Massif. In other words, the metamorphism of the cover and the core must be different as to their age and facies.

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