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Raif AKOL - Sehavet MERSİNOĞLU

MAIN OROGENIC EVENTS AND PALEOGEOGRAPHIC EVOLUTION OF TURKEY

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ABSTRACT. — The results briefly outlined here represent the continuation of the author's research upon the geotectonic evolution of Turkey previously published under the title of «Orogenic Evolution of Turkey (I959)».

This part of the work principally comprises the effects of the Prealpine-Alpine orogenic events and related changes in the paleogeography of the region. In particular, evidences on the Precambrian, Caledonian and Hercynian movements of the Premesozoic era together with the Early-Middle and Late-Alpine phases of the Mesozoic-Cenozoic period are discussed. Paleogeographic evolution related to these movements is demonstrated as series of maps and a simplified tectonic map which shows present-day structural features of Anatolia is given.

I. INTRODUCTION

As is well known, the area of Turkey lies within the Alpine-Mediterranean orogenic belt which was developed from the Tethys ocean through the long geological history. This ocean may be described as an inhomogeneous geosyncline between Eurasia and Africa.

From the paleogeographical point of view, the northern and southeastern parts of Anatolia constituted mipgeosynclinal sectors of this ocean, and the central and southern Anatolian ranges lay within the eugeosynclinal part which was also a wide subduction zone along the entire Mesozoic era. During the Cenozoic period, shallow basins had remained between already emerged or emerging masses.

II. PREALPINE OROGENIC EVENTS AND RELATED PALEOGEOGRAPHY OF ANATOLIA AT THE END OF PALEOZOIC

Evidences of the earliest known Prealpine movements are seen around Derik (Southeast Anatolia) and in the western part of Pontids.

In the Derik district, existence of a disconformity between Telbismi Formation of Eocambrian and Sadan Formation of Lower Cambrian is assumed. Thin conglomeratic unit seen at the base of the Sadan Formation contains pebbles from the Eocambrian strata. However, there is no indication of an angular unconformity between the two formations (Ketin, 1966). Principal deformation of these formations took place during the Alpine movements so that, in this area, only a sizeable uplifting (vertical movements) must have occurred just before the Cambrian period.

In the western Pontids, the unconformity between the metamorphic basement and Cambro-Ordovician elastics is more expressive (established by the M.T.A. geologists, Esen Arpat et al.). Apart from that, effects of the Caledonian movements are noted in the same region around İstanbul, Ereğli and Mudurnu. An unconformity exists between arkose series of Ordovician-Silurian age and Devonian sandy limestones in the eastern coastal area of Bosphorus, around Çamlıca and on the Princes Islands. Besides, there is a directional discrepancy between the folds of Ordovician-Silurian strata (trending almost east to west) and the overlying Devonian-Carboniferous deposits (trending mainly north to south; Ketin, 1953).

According to Tokay (1952), the clastic sequences of Devonian age unconformably overlie the Gotlandiah series to the south of Ereğli. Furthermore, a similar unconformity is present between the greenschists of Almacık Dağ Massif and the overlying Devonian strata to the north of Mudurnu. A basal conglomerate is also noted between these two sequences (Abdüsselamoğlu, 1959).

In the Zonguldak area, effects of the Early Hercynian movements are seen between Namurian and Westphalian sequences. Folding and emergence of the Namurian deposits must have occurred before Westphalian time, because coal pieces of Namurian age are found in the overlying Westphalian conglomerates.

The angular unconformity is well documented between the Triassic and Upper Paleozoic sequences of Kocaeli area. Along the recently constructed highway, the Triassic strata begins with red-colored conglomerates on the Carboniferous graywackes and shales. The unconformity is established by different attitudes of the two sequences: the Triassic strata gently dip to the east (20°-22°), whereas the Carboniferous graywackes are steeply inclined to the west (55°-60°).

Around Edremit on the Aegean cost, the Triassic sediments unconformably overlie the crystalline basement. In the Balya region, to the north, they are transgressive over the older strata, especially of Permian age. It is also evident from the transgressive nature of the Liassic deposits over the Paleozoic in general, that the Hercynian movements took place in Ankara and Gümüşhane-Bayburt section of the Eastern Pontids. In these regions, the Liassic begins with a thick basal conglomerate over the Paleozoic sequences.

Apart from these localities, the effects of the Hercynian orogeny are detected over the areas of Karaburun Peninsula and Amanos Mountains.

There are also some evidences that Hercynian movements affected the Sultan Dağları section of the Taurus Chain.

Distribution of the Paleozoic landmasses is illustrated in Plate I. Apart from that, Cambro-Ordovician, Devonian, Triassic, Liassic, Jurassic and Lower Cretaceous transgressions of Tethys over these emergent areas are marked on the map.

III. ALPINE OROGENIC EVENTS AND RELATED CHANGES IN THE PALEOGEOGRAPHY OF TURKEY

Effects of the Early Alpine orogenic events, such as Late Kimmerian and Austrian phases are noted in the central and northern parts of the Pontids, especially in the areas between Kastamonu-Abana and Sinop-Boyabat. However, the Austrian movements are more pronounced around Elazığ, Bingöl and Erzurum districts of the eastern Taurus Mountains and also around Zonguldak-Amasra region of the western Pontids.

Plate II illustrates the distribution of the lands and seas within Anatolia at the end of the Lower Cretaceous period. Paleozoic sequences and metamorphic massifs are differentiated from the Lower Mesozoic sediments which were deformed by the Early Alpine movements. Limits of the Upper Cretaceous transgression, especially in the areas of Bitlis Massif, central-eastern Taurus Mountains and Istranca Massif are also shown on this map.

First phase of severe deformation is noted in Anatolia during the Laramian culmination of the Alpine orogeny. It produced strong deformation in Taurids and Central Anatolia and acted rather mildly upon the areas of Border Folds and Pontids. Moreover this phase also corresponds to evolution of the crystalline massifs situated in Central Anatolia.

Paleogeography of Anatolia to the end of the Upper Cretaceous-Paleocene period is seen in Plate III. On the land areas, metamorphic massifs, acid intrusions, ultramafics, radiolarite-ophiolite facies and the sedimentary sequences which were principally subjected to the Laramian diastrophism are distinguished.

The state of the Anatolian Eugeosyncline—situated between the earlier cratonized Pontids blocks in the north and Arabian Platform in the south—, at the end of the Upper Cretaceous-Paleocene period, is shown in Plate IV. The author is of the opinion that this eugeosynclinal area was also a region of subduction. In Plate IV, the distribution of metamorphic massifs and sedimentary sequences of Paleozoic and Lower Mesozoic times, ultramafic complexes, ophiolite-radiolarite series of Cretaceous-Paleocene ages and the state of Mediterranean Sea during the Tertiary period (white areas) are seen.

Close relationship between the metamorphic massifs containing acid intrusions and the radiolarite-ophiolite sequences with ultramafics, which are seen occurring along the borders of the cratonic regions can be easily established. So, it seems clear that the ultramafic masses seen in Anatolia were emplaced into the upper crustal level by compressional movements (obduction) during the Mesozoic era rather than by tensional movements, as suggested by Brinkmann (1972).

Following the Laramian culmination, a second significant orogenic event was Pyrenean paroxysm which caused severe deformations in the Northern Anatolian Range. The effects of this phase are recognized along the Black-Sea coast around Sile, Cide and Sinop.

Blumenthal (1952, 1956) put forward strong evidences that unconformities exist between the Eocene and Oligocene sequences in the Bolkardağ area, and between the Middle and Upper Eocene strata in the Aladağ district of the Taurus Mountains (between Niğde and Adana). However, the main deformational phase occurred between Oligocene and Miocene times (Savian movements) in the Central and Western Taurus Mountains. Here, the sequences of Miocene age transgressively overlie the older formations with an angular unconformity.

Plate V represents the paleogeography of Turkey, or distribution of the land areas at the beginning of Miocene time. Gridded sections show the land areas on which lagoonal, continental-lacustrine and volcanic basins are distinguished. On the other hand, the blank areas represent the limits of marine transgression of Miocene time.

The effects of the third paroxysmal orogenic movements, which occurred at the close of Miocene time (Rhodanian phase), are recognized in the Border-Folds area, Southeastern Turkey. In this region, the Miocene and, in part, the Lower Pliocene strata were subjected to strong folding and the rocks older than Miocene were thrusted over the younger sequences for several kilometers (15-20 km). In addition to these movements, which represent the principal period of deformation in the area of Border Folds, the effects of the Walachian phase are also recognized, so that the Upper Pliocene sediments were also deformed in this youngest mountain range of Anatolia.

The present-day structural features of Turkey are shown in Plate VI, on which the areas deformed during the various culminations of the Alpine and Prealpine orogenies, major fault systems (normal, thrust and strike-slip) and extinct volcanoes of the Late Tertiary-Quaternary period are separately marked.

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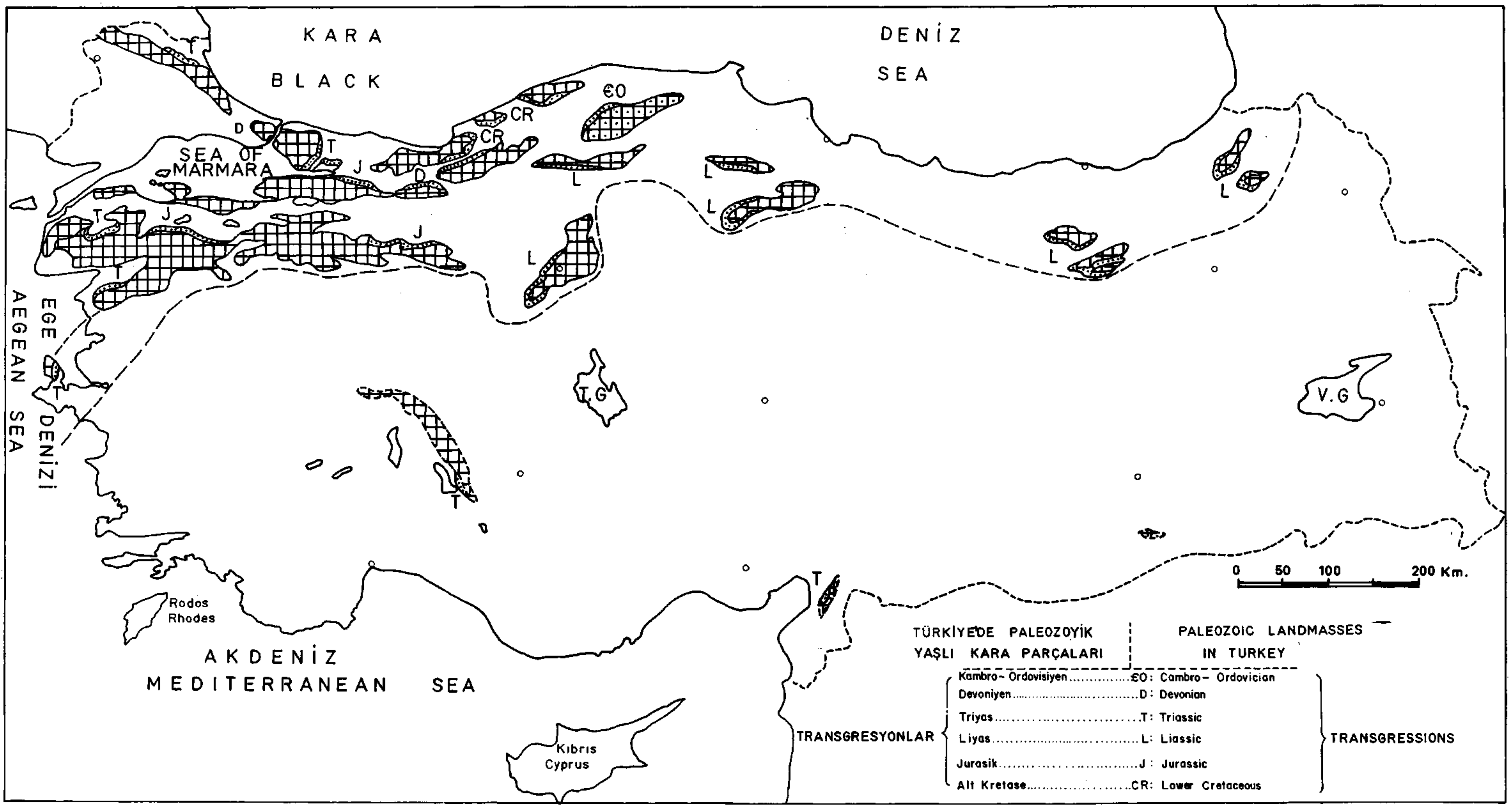
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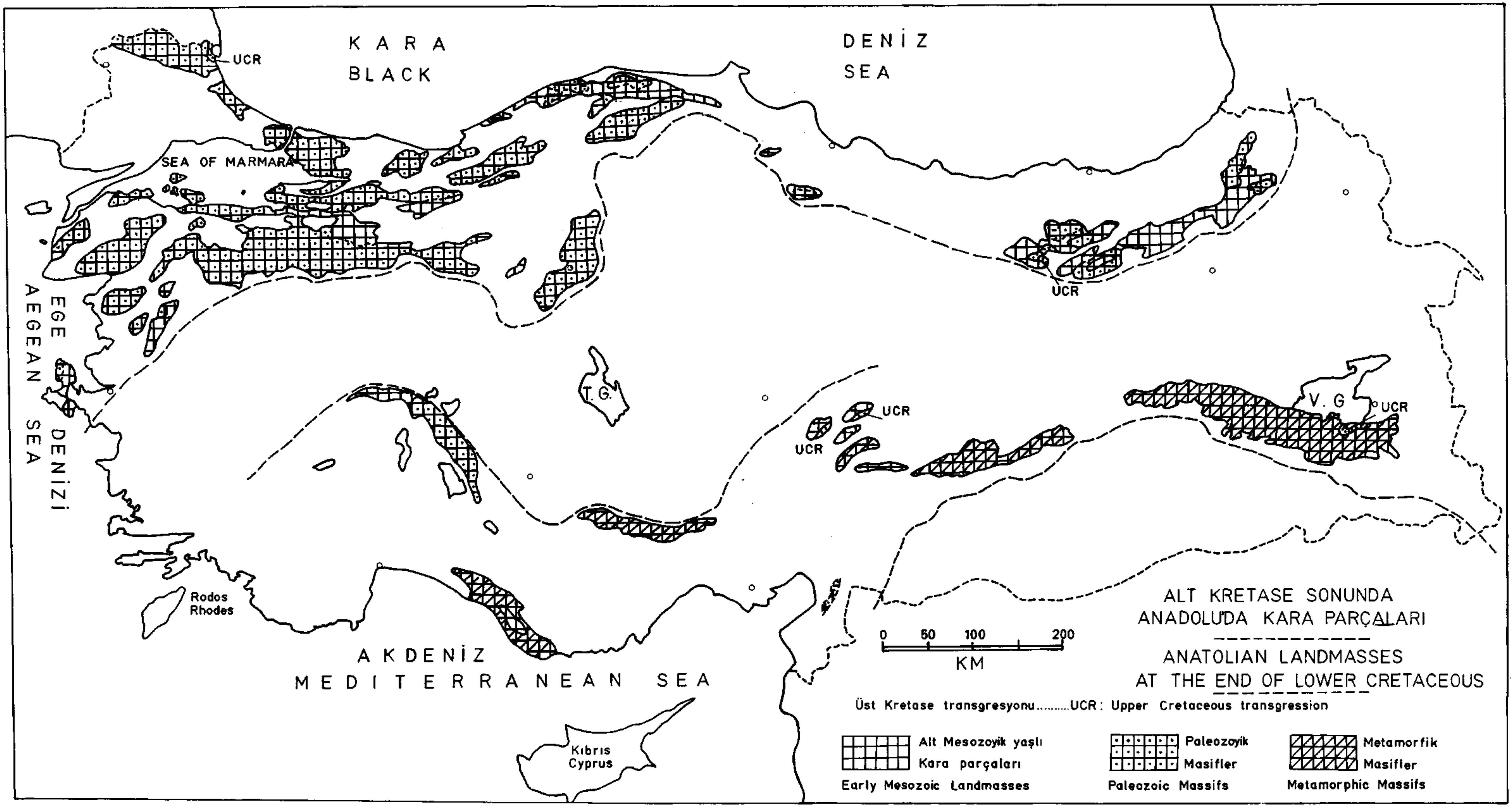
TÜRKİYEDE PALEOZOYİK YAŞLI KARA PARÇALARI
PALEOZOIC LANDMASSES IN TURKEY
TRANSGRESYONLAR
Kambro- Ordovisiyen .... €O: Cambro- Ordovician
Devoniyen .... D: Devonian
Triyas .... T: Triassic
Liyas .... L: Liassic
Jurasik .... J: Jurassic
Alt Kretase .... CR: Lower Cretaceous
TRANSGRESSIONS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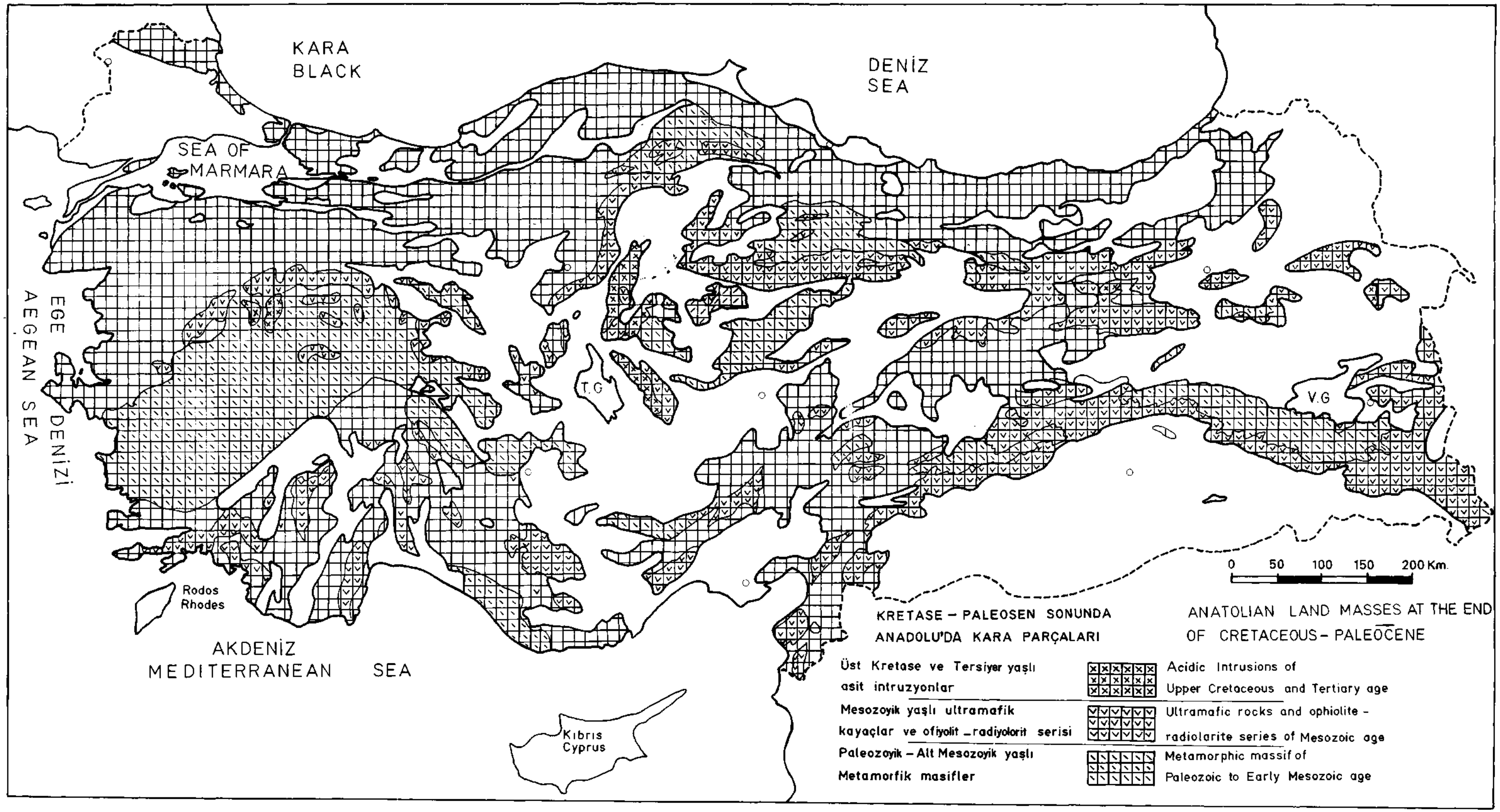
ALT KRETASE SONUNDA
ANADOLU'DA KARA PARÇALARI
ANATOLIAN LANDMASSES
AT THE END OF LOWER CRETACEOUS
Üst Kretase transgresyonu..........UCR: Upper Cretaceous transgression
Alt Mesozoyik yaşlı Kara parçaları
Early Mesozoic Landmasses
Paleozoyik Masifler
Paleozoic Massifs
Metamorfik Masifler
Metamorphic Massifs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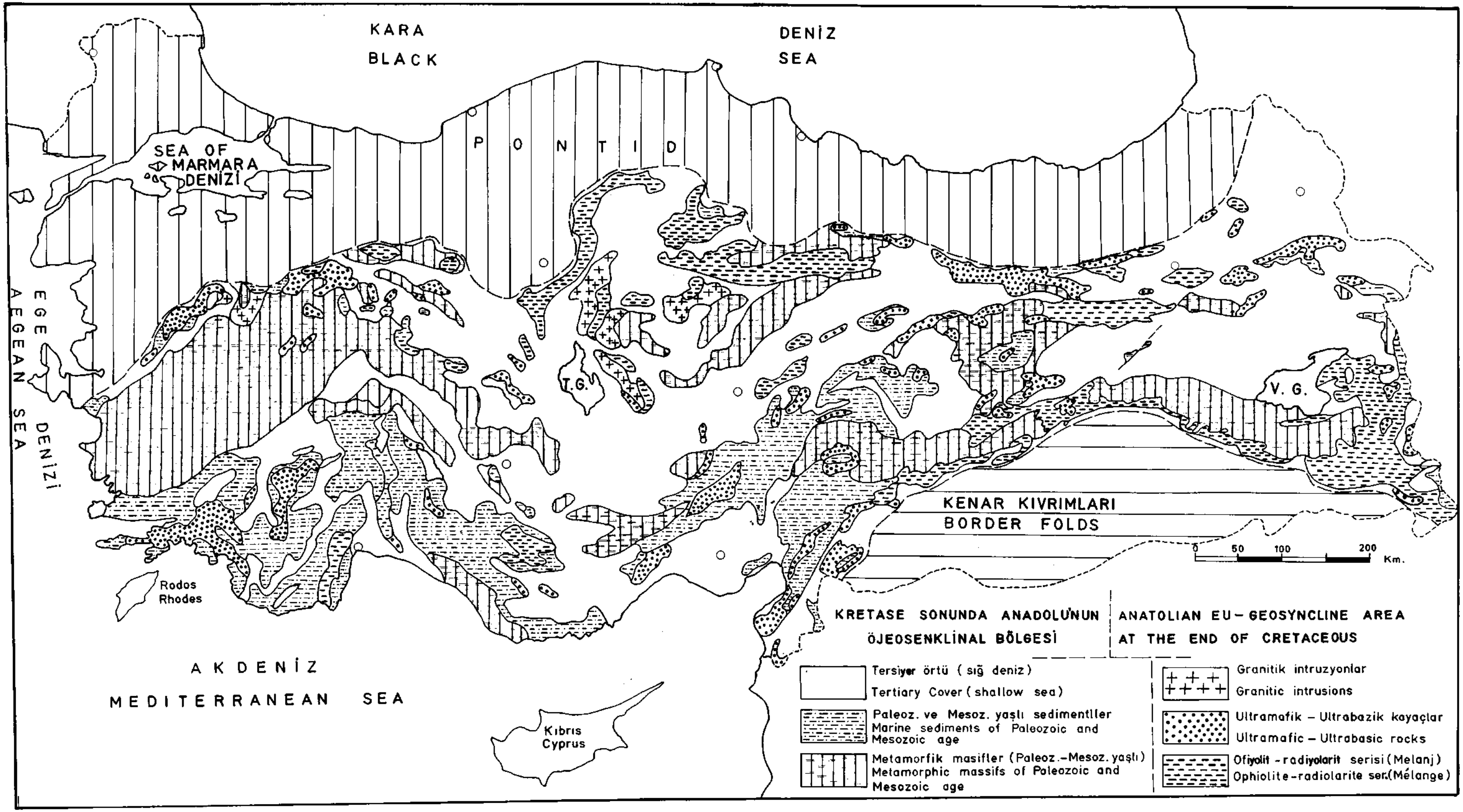
KRETASE – PALEOSEN SONUNDA
ANADOLU'DA KARA PARÇALARI
ANATOLIAN LAND MASSES AT THE END
OF CRETACEOUS – PALEOCENE
Üst Kretase ve Tersiyer yaşlı
asit intruzyonlar
Acidic Intrusions of
Upper Cretaceous and Tertiary age
Mesozoyik yaşlı ultramafik
kayaçlar ve ofiyolit – radiyolorit serisi
Ultramafic rocks and ophiolite –
radiolarite series of Mesozoic age
Paleozoyik – Alt Mesozoyik yaşlı
Metamorfik masifler
Metamorphic massif of
Paleozoic to Early Mesozoic age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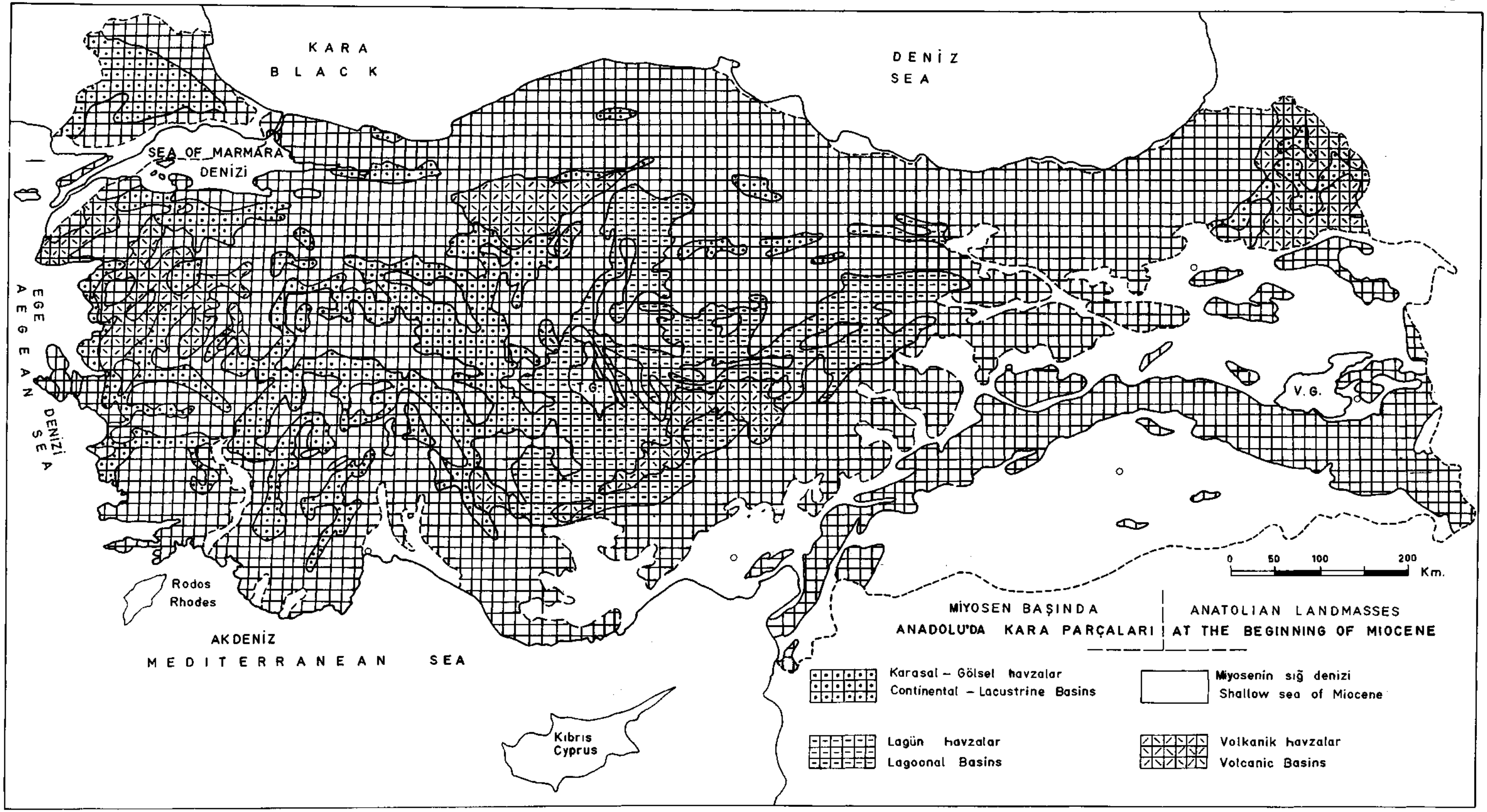
KENAR KIVRIMLARI
BORDER FOLDS
0 50 100 200 Km.
Rodos
Rhodes
AKDENİZ
MEDITERRANEAN SEA
Kıbrıs
Cyprus
KRETASE SONUNDA ANADOLU'NUN ÖJEOSENKLİNAL BÖLGESİ
ANATOLIAN EU-GEOSYNCLINE AREA AT THE END OF CRETACEOUS
Tersiyer örtü (sığ deniz)
Tertiary Cover (shallow sea)
Paleoz. ve Mesoz. yaşlı sedimentler
Marine sediments of Paleozoic and Mesozoic age
Metamorfik masifler (Paleoz.-Mesoz. yaşlı)
Metamorphic massifs of Paleozoic and Mesozoic age
Granitik intruzyonlar
Granitic intrusions
Ultramafik - Ultrabazik kayaçlar
Ultramafic - Ultrabasic rocks
Ofiyolit - radiyolarit serisi (Melanj)
Ophiolite-radiolarite ser.(Mélange)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Rodos
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MEDITERRANEAN SEA
Kıbrıs
Cyprus
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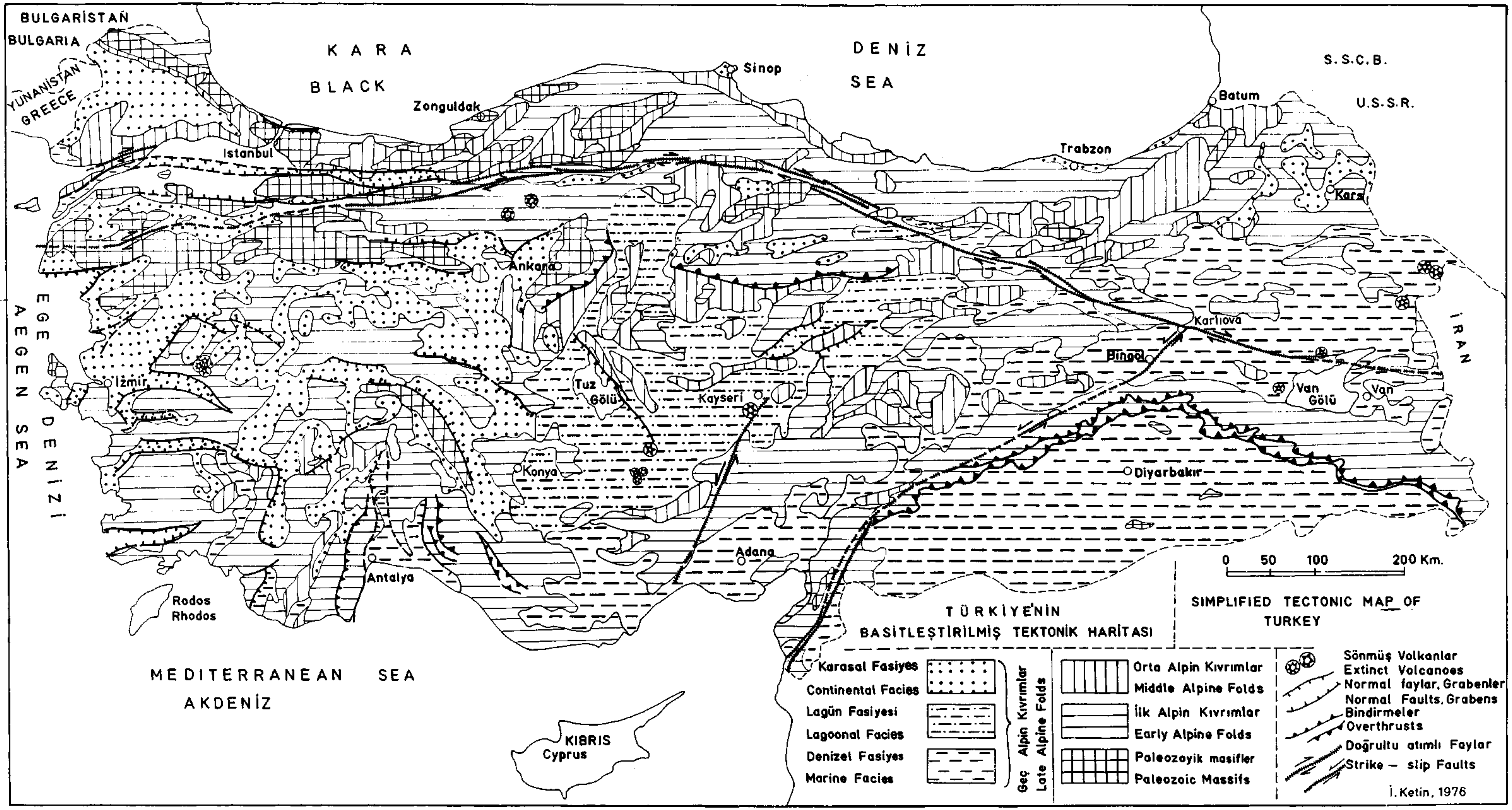
MİYOSEN BAŞINDA
ANADOLU'DA KARA PARÇALARI
ANATOLIAN LANDMASSES
AT THE BEGINNING OF MIOCENE
Karasal – Gölsel havzalar
Continental – Lacustrine Basins
Miyosenin sığ denizi
Shallow sea of Miocene
Lagün havzalar
Lagoonal Basins
Volkanik havzalar
Volcanic Basins


BULGARİSTAN
BULGARIA
YUNANİSTAN
GREECE
KARA DENİZ
BLACK SEA
Sinop
Zonguldak
Istanbul
Trabzon
Batum
S.S.C.B.
U.S.S.R.
Kars
Ankara
Karlıova
Bingöl
İRAN
EGE DENİZİ
AEGEN SEA
İzmir
Tuz Gölü
Kayseri
Van Gölü
Van
Konya
Diyarbakır
Adana
Antalya
Rodos
Rhodos
0 50 100 200 Km.
TÜRKİYE'NİN BASİTLEŞTİRİLMİŞ TEKTONİK HARİTASI
SIMPLIFIED TECTONIC MAP OF TURKEY
MEDITERRANEAN SEA
AKDENİZ
KIBRIS
Cyprus
Karasal Fasiyes
Continental Facies
Lagün Fasiyesi
Lagoonal Facies
Denizel Fasiyes
Marine Facies
Geç Alpin Kıvrımlar
Late Alpine Folds
Orta Alpin Kıvrımlar
Middle Alpine Folds
İlk Alpin Kıvrımlar
Early Alpine Folds
Paleozoyik masifler
Paleozoic Massifs
Sönmüş Volkanlar
Extinct Volcanoes
Normal faylar, Grabenler
Normal Faults, Grabens
Bindirmeler
Overthrusts
Doğrultu atımlı Faylar
Strike – slip Faults
İ. Ketin, 1976