ROCK UNITS AND METAMORPHISM OF THE BASEMENT AND LOWER PALEOZOIC COVER OF THE BITLIS METAMORPHIC COMPLEX, SE TURKEY

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Rock units and metamorphism of the Basement and Lower Paleozoic cover of the Bitlis Metamorphic Complex, SE Turkey: in: Göncüoğlu, M.C.and Derman, A.S.(Eds), Lower Paleozoic Evolution in northwest Gondwana, Turkish Assoc. Petrol. Geol., Spec. Publ.,No: 3, 75-81, Ankara.

ABSTRACT

Bitlis Metamorphic Complex is composed of numerous tectonic slivers consisting of discontinuous sequences of a pre-Lower Paleozoic "Basement" and its Paleozoic-Mesozoic "Cover".

The "Basement" (Hizan Metamorphics) comprises ortho and para gneisses with rare bands and lenses of eclogites, kyanite eclogites, meta gabbros and garnet amphibolites in its lower part. The upper part is mainly represented by meta porphyroides, felsic metatuffs and apatite bearing greenschists and metaclastics. The metamorphic mineral paragenesis and the presence of migmatites indicate to a plurifacial HT/HP event of Pre-Cambrian age in the basement.

The "Cover" (Mutki Metamorphics) unconformably covering the basement rocks starts with meta-conglomerates and grades upwards into variegated, cross-bedded and well sorted meta-quartzites. The meta clastics are followed by quartz-muscovite schists, dark colored slates and calcschists and albite-epidote-chlorite schists. Lenses and bands of dolomites and recrystallized limestones conformably covering the schists contain *Actinostroma allathratum* Nich., *Actiriostroma* sp., *Thamnopora* sp., *Favosites* sp. together with *Coactilum straeleni*, *Girvenella amplefurcata*, Girvenella ducii and Pyenostroma sp. indicating to Middle-Upper Devonian depositional age. Upwards the sequence is represented by olistostromal volcaniclastics, recrystallized limestones and felsic-mafic meta-volcanics of Carboniferous age and unconformably covered by Lower Permian fossiliferous meta-carbonates. Metadiabase dikes are frequently observed within this part.

In the meta-clastics and meta-basic rocks of the lower part of the cover sequence: albite+chlorite+chloritoide, albite+biotite+chlorite+muscovite and albite+chlorit+stilpnomelane+chloritoide are the common assemblages. These paragenesis indicate to an alpine low grade metamorphic event, which is represented by similar retrograde assemblages in the basement rocks.

It is suggested that the "Basement" of the Bitlis Metamorphic Complex together with the basement of the SE Anatolian Autochton and the Taurides in the south and İstanbul Unit in the north represent parts of a pre-Cambrian orogenic collage. The differences in the Lower Paleozoic cover, however, indicate that the northern and the southern terranes were separated by an intervening deep (oceanic?) basin.

INTRODUCTION

Bitlis Metamorphic Complex (BMC) is an alpine structure in SE Anatolia (Figure 1). It consists of a large number of south vergent slices of metamorphic and sedimentary rocks and represents the northernmost edge of the Arabian Platform, which has been deformed and metamorphosed during the closure of the Southern Branch of Neotethys (Göncüoğlu and Turhan, 1984, Yazgan, 1984; Yazgan and Chessex, 1991). The primary contact to the northern terrane, SE Anatolian Ophiolite Belt, is a thrust surface. Towards west Bitlis Massif is bounded by the East Anatolian Fault, a major left-lateral strike-slip fault.

Bitlis Metamorphic Complex constitutes a medium-high grade metamorphic basement and cover units of Paleozoic-Mesozoic age (Figure 2). (Boray, 1973; Hall, 1976; Yılmaz, 1975; Savcı et al., 1979, Göncüoğlu, 1983; Göncüoğlu and Turhan, 1983, 1984, 1985; Çağlayan et al., 1984; Yazgan and Chessex, 1991; Yılmaz, 1993; Şengün, 1995)

The rock units of the basement and the lower part of the Paleozoic cover is the main topic of this paper.

The initiation of the alpine cycle in BMC is characterized by the Middle Triassic meta-volcanics and volcanictastics, which are related to the rifting and opening of the "Southern Branch of Neotethys". These volcanic rocks are conformably overlain by a condensed series, mainly consisting of metapelites interlayered with basic metavolcanics, metacherts and metatuffs of Upper Triassic-Lower Cretaceous age. This sequence is interpreted as the northernmost slope deposits of the Arabian passive margin, facing toward the Southern Branch of Neotethys. Ophiolites and ophiolitic olistostromes of Upper Cretaceous age are observed as thrust sheets on the metamorphics. The metaclastics of the alpine cover sequence contain paragenessis that indicate to an alpine low-grade metamorphic event. This alpine overprint is documented by geological and radiometric data (Yılmaz, 1975; Yazgan, 1984).

The overstep sequences in BMC are represented by Middle Eocene shallow marine sediments. During ?Lower Miocene the BMC is imbricated and emplaced on the foreland deposits of the southeastern Anatolian Autochthon, northern margin of the Arabian Microplate.

Equivalents of Bitlis Terrane occur as metamorphic inliers within the Sanandaj-Sirjan Zone of the Zagros Belt.

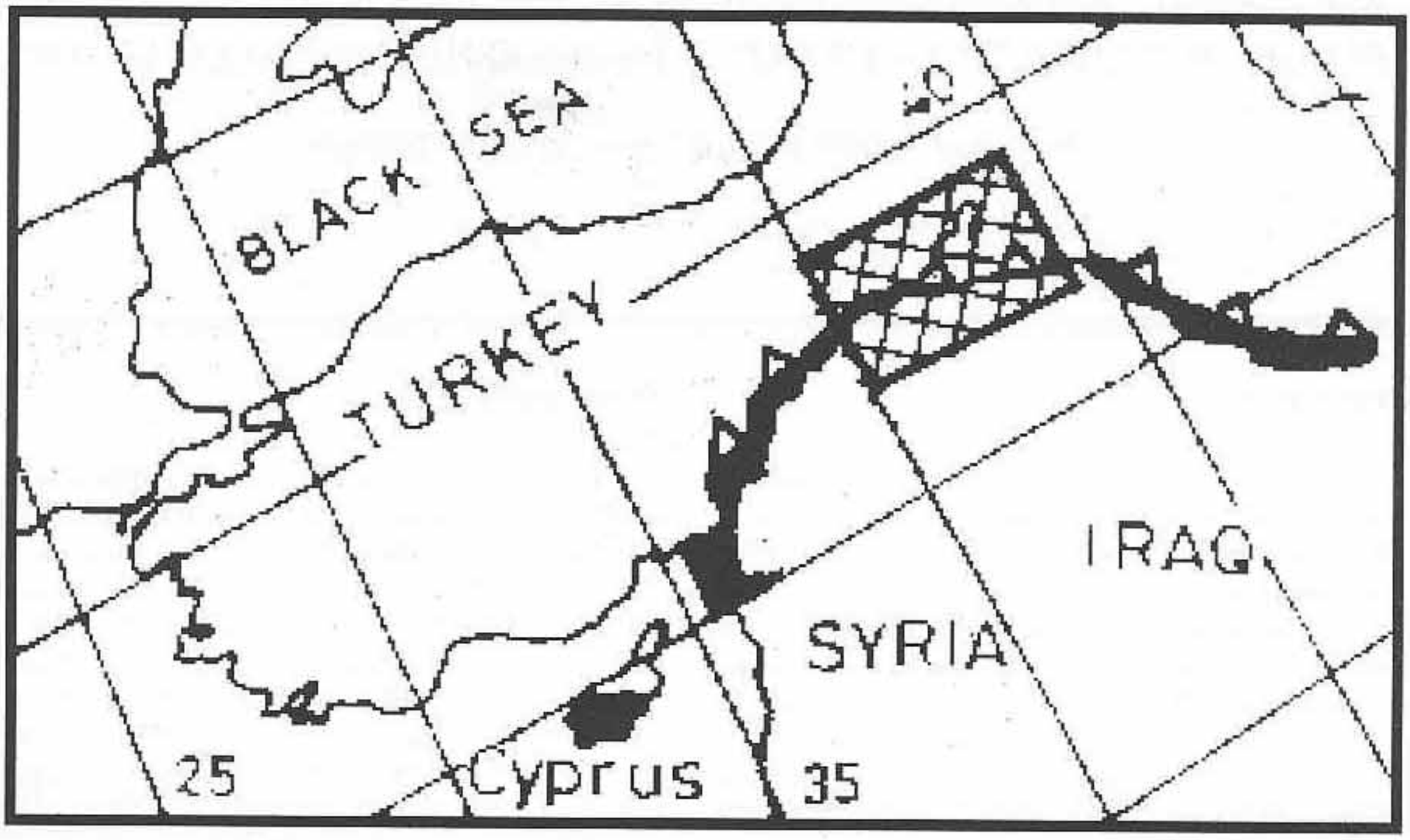

Figure 1. Location map of the Bitlis Massif.

ROCK-UNITS OF THE BASEMENT

The basement rocks of the BMC is represented by Hizan Metamorphics. Hizan Metamorphics occur as kilometers thick, east-west trending thrust sheets in the northern part of the Bitlis Massif (Figure 2).

The dominating lithology of the Hizan Metamorphics is the Andok Gneiss Complex consisting of sillimanite bearing garnet-muscovite-biotite gneisses, augen-gneisses and hornblende-biotite gneisses of probable igneous origin (Figure 3). Discontinuous bands and lenses of calcsilicate carbonates are very rare. The amphibolites, amphibole-eclogites, eclogites and kyanite-eclogites are found as layers and lenses in the Andok Gneiss Complex (Okay et al., 1985). Apart from the eclogitic bodies, bands and layers of coarse-grained pegmatitic gabbro and layered amphibolite (?layered gabbro) has been observed in different parts of the complex (Göncüoğlu and Turhan, 1985).

The relatively upper part of the Hizan Metamorphics include biotite-muscovite schists, garnet bearing micaschists, muscovite-quartz schists with bands and lenses of kyanite and dumortierite bearing muscovite-quartz schists. The protoliths of this unit is interpreted as volcaniclastic and clastic rocks.

The dominance of meta-porphyroides, felsic metatuffs and apatite bearing greenschists in the upper part of the Hizan Metamorphics is very typical. This upper part of the unit can correlate with the pre-Early Cambrian Telbesmi formation of the Arabian Platform (Bozdoğan et al., 1996) or with the Infra-Cambrian Emirgazi formation (Kozlu et al., 1995) of the Tauride Belt.

The age of the Hizan Metamorphics is mainly based on geochronological data. Relying on Rb/Sr whole-rock data, Yılmaz et al. (1981) suggest that the main metamorphic event took place in earliest Cambrian time. This suggestion implies that the formation age of the Hizan Metamorphics is Pre-Cambrian.

PALEOZOIC COVER

The low-grade metamorphic rocks unconformably overlying the Hizan Metamorphics were named as Mutki Metamorphics by Göncüoğlu and Turhan (1985).

From bottom to the top Mutki Metamorphics contain Meydan formation, Çeşme formation, Cırnık limestone and Malato limestone (Figure 3).

Meydan Formation

In its lower part Meydan formation starts with brown-gray colored, massive, microconglomeratic recrystallized limestone (Figure 4). The clasts of the conglomerate consist of quartz, feldspar, biotite and tourmaline. Rock-fragments are mainly derived from felsic volcanics and muscovite-biotite schists. This basal part is followed by a thick succession of brown-gray impure meta-sandstones. The clasts of this unit are: quartz, muscovite, calcite and albite. Very fine-grained hematite and specularite may reach up to 15%. The upper part of this level is represented by very typical gray, pink and violet colored quartzites displaying lamination and cross-bedding. Under the microscope the quartzites are composed of fine grained, quartzose bands alternating with fine

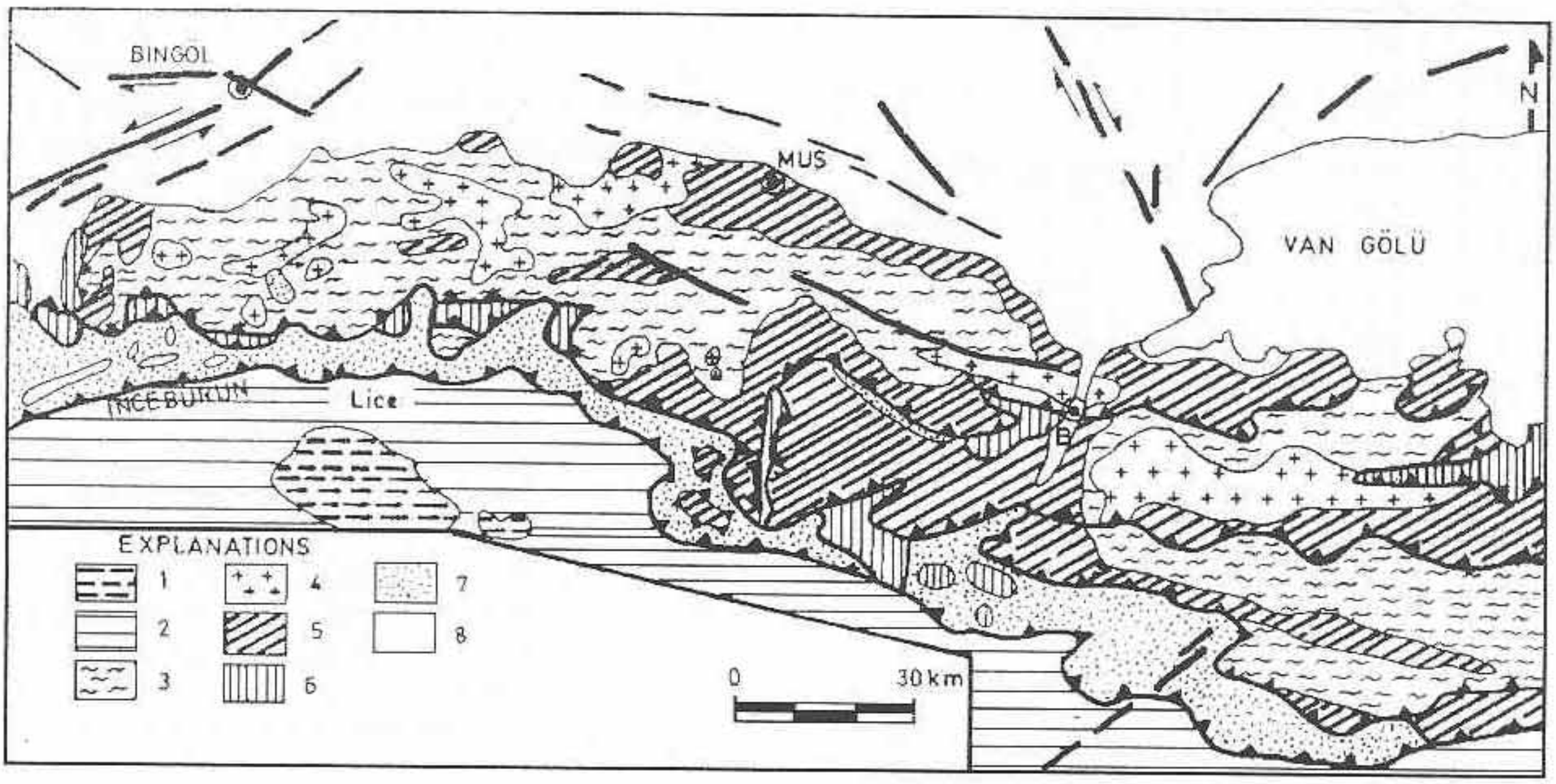

Figure 2. Simplified geological map of the Bitlis Metamorphic Complex (after Göncüoğlu and Turhan, 1985). 1- Paleozoic units of the SE Anatolian Autochton, 2- Tertiary cover of the SE Anatolian Autochton, 3- Pre-Cambrian "Basement" Units (Hizan metamorphics), 4- Granitoids, 5- Paleozoic-Mesozoic "Cover" Units (Mutki Metamorphics), 6- Alpine Ophiolites, 7-Tertiary foreland deposits, 8- Tertiary cover of the Muş Basin.

bands of muscovite and chlorite. With increasing amounts of mica and feldspars the quartzites are transitional to graphite-rich muscovite-albite-quartz phyllites, chlorite-actinolite-clinozoisite schists and chlorite-actinolite-albite rich calcschists. This unit is yellow-green colored, well foliated and thin-bedded. Discontinuous bands and lenses of thin-bedded, laminated dolomites and sandy limestones and brown, massive dolomites are noticed at the lower part of the phyllites.

An almost 150 meters thick, gray colored, medium to thick bedded dolomitic limestone and dolomite member on the phyllites (Figure 4) contains corals, bryozoans, algea and crinoids. *Actinostroma alathratum* Nich., *Actriostroma* sp and *Thamnophora* sp., *Favosites* sp. (Det. C. Kırağlı) has been determined from middle and upper part of the member. The dolomitic limestone layers from the same layers yielded *Coactilum (spaerocodum) straeleni* Lacompte, *Girvenella amplefurcata* Pia, *G. ducii* Lacompte and *Pyenostroma* sp. (Det. N. Atabey), suggest a Givetian-Frasnian age.

The fossiliferous carbonates are conformably overlain by a thick sequence of albite-chlorite phyllite, sericite-quartz phyllite, actinolite-chlorite schists and chloritoid- bearing albite-chlorite-quartz phyllites.

The lower part of the Meydan formation correlate well with the Cambrian Sadan, Koruk and Sosink formations of the Arabian Platform in Derik area. The relatively thick shale-dominated Seydişehir formation of the Arabian Platform is apparently not represented in the Bitlis area. The fossiliferous Late Middle-to Upper Devonian carbonates of the study area may correspond to the Kayayolu formation of the same age in the Arabian Platform.

Çeşme Formation

The felsic meta-volcanic, -volcaniclastic and -clastic rocks with blocks of dolomites and greenschists transitionally overlying the Meydan formation in Bitlis Massif are named as Çeşme formation (Göncüoğlu and Turhan, 1983). The felsic meta volcanics occur as dome-shaped bodies. Felsic meta-tuffs and porphyritic meta-rhyolites alternate with metaagglomerates and mafic/intermediate metavolcanics (metalatites?) (Göncüoğlu, in print). Blocks and bands of fine-grained recrystallized limestones and calc-schists are the other constituents. Rare mylonitic aplite dikes cut the meta-rhyolites.

Çesme Unit shows gradual contacts with the underlying fossiliferous metacarbonates of Middle-Upper Devonian age and unconformably overlain by Lower Permian Cırnık limestone. This geological data clearly indicate the presence of an important volcanic event during Carboniferous, which is temporally in accordance with the granitic intrusions in the Bitlis Massif (Göncüoğlu, 1983; Helvacı and Griffin, 1984).

Cırnık and Malato Limestone

Cırnık limestone starts at its basement with a thin, carbonate-rich basal meta-conglomerate with granite and felsic volcanic pebbles disconformably covering the Cesme Unit. The meta-conglomerate is followed by

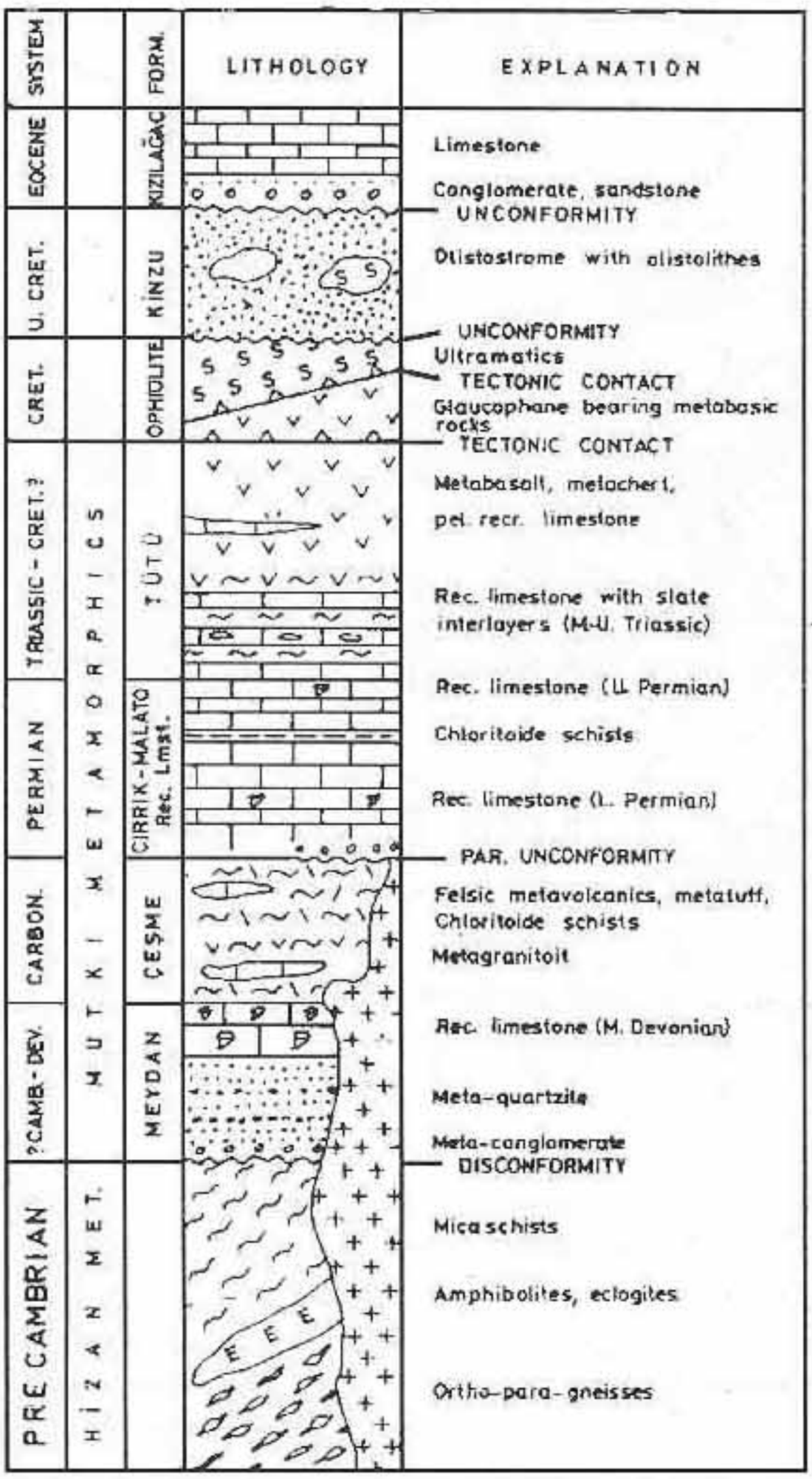

Figure 3. Generalized columnar section of the Bitlis Metamorphic Complex.

medium to thick bedded, dark colored, almost 200 meters thick fossiliferous recrystallized limestones. In the dark colored lower part Göncüoğlu and Turhan (1983) reported *Yatsengia ibuhiensis* Minato and *Parafusilina* sp. suggesting a Lower Permian age. Malato limestone is transitional to the Cırnık limestone and consists of gray-yellow and buff colored, thick bedded limestones with interlayers of pink-yellow colored, thin-bedded calc-schists. Coral and Foraminifera data suggest a Late Permian age. Permian Limestones of the Bitlis Massif can be correlated with the Tanin and Cudi Groups of the Arabian Platform.

METAMORPHIC FEATURES OF BİTLİS METAMORPHIC COMPLEX

Common mineral assemblage in the metapelites of the basement, which is found as relicts, contain: sillimanite+garnet+biotite+K-feldspar+plagioclase. Eclogites are characterized by the assemblage: omphacite+garnet+kyanite+zoisite and omphacite+garnet+Ca-amphibole. This data and the presence of migmatites indicate to a plurifacial HT/HP event in the basement. In the clastic rocks of the Lower Paleozoic-Mesozoic sequence albite+chlorite+chloritoide, albite+biotite+chlorite+muscovite and albite+chlorite+stilpnomelane are the common assemblages. These paragenesis indicate to an alpine low grade metamorphic event (greenschist facies, Boray, 1973) which is represented by similar retrograde assemblages in the basement rocks.

DISCUSSION AND CONCLUSIONS

In the Eastern Mediterranean region pre-Lower Paleozoic rocks occur as discontinuous outcrops in most of the alpine terranes (Göncüoğlu, this volume). Two distinct zones with differing lithologies can be recognized: a) a northern zone which crops out in the basement of Carpato-Balkan, Istanbul and Main Range terranes, and b) a southern zone which is recorded in the basement of the Tauride and Iranian terranes.

The rock units of the northern zone in Carpato-Balkan area are mainly characterized by garnet-bearing and garnet-free amphibolites with lesser amounts of gabbros, serpantinites, plagiogranites and local eclogites. The basement rocks of Istanbul Terrane constitute layered and isotope metagabbros, amphibolites and metabasalts intruded by granitoids. Subunits of the Main Range Terrane in the Greater Caucasus also consist of ortho-amphibolites of oceanic affinity. Cambro-Ordovician sediments are unconformably overlying the basement rocks.

In the southern zone, except the Mishkan salient in Nahcevan Terrane and Bitlis Metamorphics in Eastern Taurides where meta-ophiolitic rocks are found as discontinuous outcrops, the basement rocks in the SE Anatolian Autochton and Taurides (s.l.) in Turkey and Albruz in Iran are mainly characterized by granitoids and felsic-intermediate volcanics intruding low-grade metamorphic assemblages of continental crust origin. In both regions, a very thick non-metamorphic sequence (including diabase dykes in the Tauride part) of "Infra-Cambrian" age represents the upper part of the basement.

In the Arabian Platform, where Lower Cambrian is covering the earlier units with an angular unconformity, the "Infra-Cambrian" units are mainly represented by andesitic volcanics, volcaniclastics and siliciclastic sediments, indicating to a intracratonic shallow marine depositional environment.

In the Eastern and Central Taurides of Southern Turkey the "Infra-Cambrian" unit consist of two members (Kozlu et al., 1995). The lowermost member is represented by an alternation of red-green-gray colored arkoses and shales. This member with its well developed parallel lamination and cross-bedding is very probably deposited in a periodically subsiding shallow-marine environment. Upwards follows varicolored stromatolitic and cherty limestones interlayered with sandstones and shales. The stramatolitic dolomites and limestones of this

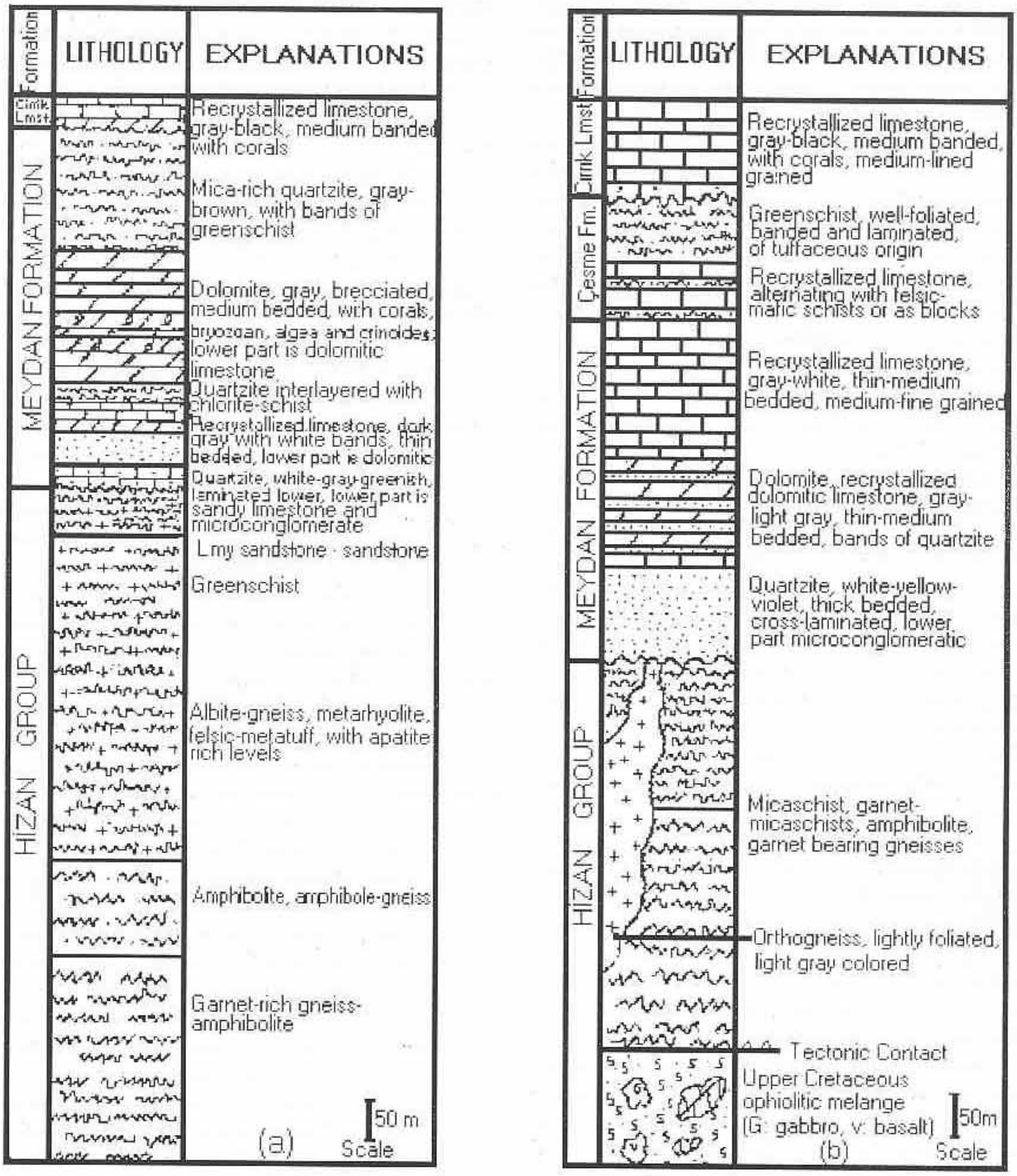

Figure 4. Columnar sections showing the Hizan metamorphics and the Paleozoic cover (a- Aridag Section, b- Tagköy Section).

member are interpreted as sabkha deposits. The cherty limestones and calci-turbiditic limestones of the same unit, are suggested to be the products of a silica-rich lagoon or shallow and/or deep marine environment. The presence of cross-bedded sandstones between the barite-bearing limestone layers further suggest a shallow depositional environment.

The "Basement" (Hizan Metamorphics) comprises ortho- and para-gneisses with rare bands and lenses of eclogites, kyanite eclogites, meta-gabbros and garnet amphibolites in its lower part. These lithologies suggest an oceanic island arc setting. The metamorphic mineral paragenesis and the presence of migmatites indicate to a plurifacial metamorphic event in the basement. The upper part of the Hizan Metamorphics, however, is mainly represented by meta-porphyroides, felsic metatuffs and apatite bearing greenschists and metaclastics resembling the "Infra-Cambrian" lithologies mentioned above.

The pre-Lower Paleozoic age of the metamorphism in the basement is clearly documented by the presence of HT/HP metamorphic clasts in the basal micro-

conglomerates of the Lower Paleozoic cover. This geological data confirm the Rb/Sr isochrone ages from the basement (Helvacı and Griffin, 1983, 1984). Thus, a Pre-Cambrian or pre-Lower Paleozoic age has been assigned to the basement of the BMC.

We assume that the basement rocks of both the southern zone (Tauride and Iranian terranes including the basement of the BMC) and northern zone (Carpato-Balkan, Istanbul and Main Range terranes) can be interpreted as remnants of a Pre-Cambrian orogenic collage with oceanic, arc-type and continental elements which were rifted away and re-amalgamated to the northern margin of Gondwanaland during following Late Variscan, Cimmerian and Alpine orogenic events.

The "Cover" (Mutki Metamorphics) unconformably covering the basement rocks starts with meta-conglomerates and grades upwards into variegated, cross-bedded and well sorted meta-quartzites. The meta-clastics are followed by quartz-muscovite schists, dark colored slates and calcschists and albite-epidote-chlorite schists. Lenses and bands of dolomites and recrystallized limestones conformably covering the schists contain Middle-Upper Devonian fossils. In the meta-clastics and meta-basic rocks of the lower part of the cover sequence: albite+chlorite+chloritoide, albite+biotite+chlorite+muscovite and albite+chlorite+stilpnomelane+chloritoide are the common assemblages. These paragenesis indicate to an alpine low grade metamorphic event, which is represented by similar retrograde assemblages in the basement rocks.

It is suggested that the Lower Paleozoic "Cover" of the Bitlis Metamorphics can be well correlated with those of the Arabian Platform and the Tauride-Anatolide Units in Turkey.

On the other hand it is shown by detailed stratigraphical work by Dean et al. (1995) that the geological history of the Lower Paleozoic of the northern zone notably differ from that of the southern zone.

Based on this data it is suggested that the Lower Paleozoic units of the SE Anatolian Autochton (including the BMC) and the Taurides were deposited mainly in northwest-facing platforms and basins developed on the Pre-Cambrian orogenic belt and were separated from the Balkan-Pontide terrane by an intervening deep (oceanic?) basin.

ACKNOWLEDGMENTS

The fieldwork was realized within the framework of a TPAO-MTA joint project. The authors thank late O. Sungurlu, Dr. H. Savcı and F. Yöndem for their contributions during the fieldwork. This paper is a contribution to IGCP Project 351 "Early Paleozoic Evolution of NW Gondwana".

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